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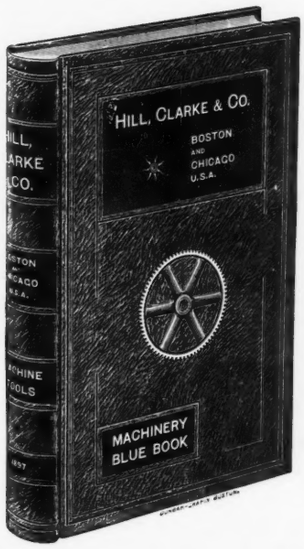
MACHINERY:

VOL. 3. Nº 9. PUBLICATION OFFICE 411-418 PEARL STREET NEW YORK CITY. MAY: 1897.

A PRACTICAL JOURNAL FOR MACHINISTS AND ENGINEERS AND FOR ALL WHO ARE INTERESTED IN MACHINERY:



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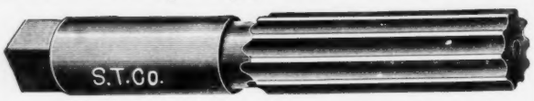

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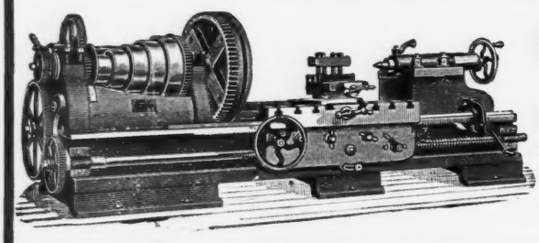

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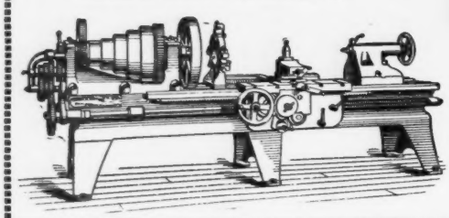

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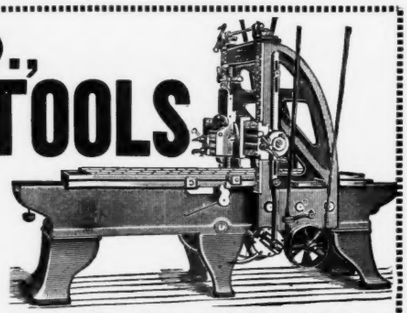


Send for Second-Hand List.

MACHINERY.

VOL. 3. May, 1897. No. 9.

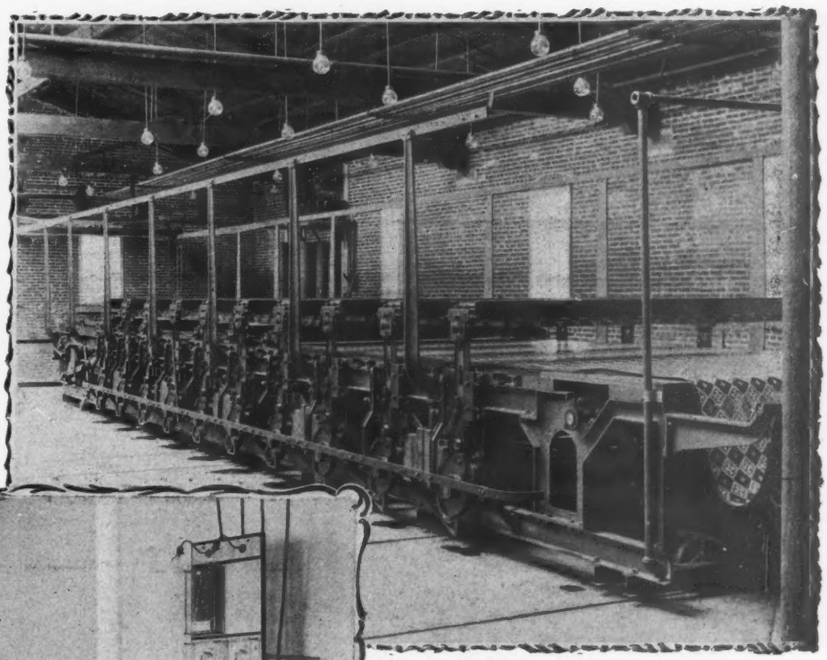
ELECTRICITY IN AN OIL CLOTH FACTORY.

S. ASHTON HAND.

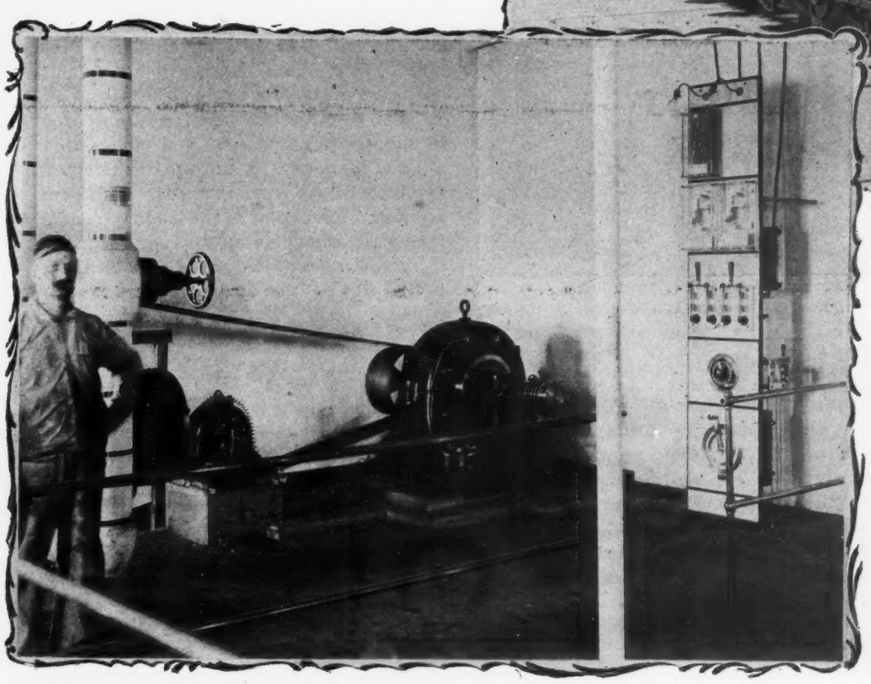
AN electric power and lighting plant has recently been installed in the new factory of the Farr & Bailey Manufacturing Co., oil-cloth manufacturers, of Camden, N. J., which possesses many points of novelty and interest for engineers.

There are but few industries, from dentistry to the manufacture of steel rails in which electric power is not employed, but until very recently electric motors have been excluded from all industries in which inflammable gases or vapors are present in the atmosphere of the factory, for the reason that even the slighest spark, which might be present at the brushes, is likely to cause an explosion. Such an industry is the manufacture of oil-cloth, for here the large quantities of naphtha used about the machinery cause the air to become at times charged with an explosive vapor, while the fumes given off by the oil-cloth during the process of drying, are inflammable—so inflammable, indeed, that several fires in these factories have been started by even the small spark caused by the electro-static discharge from ordinary rapidly-running belting, such a spark as any one may produce by presenting his knuckle to a belt running in a dry room.

All direct current motors have, while in operation, a slight spark where the brushes touch the commutator and sometimes this sparking is not very noticeable, but often so violent as to partly fuse the brushes and commutator bars. Consequently, the use of electric motors in factories of this kind has been out of the question until the danger of fire from sparking was removed by the advent of the Tesla motor, which is so constructed that there is no possibility of sparking.



OIL CLOTH PRINTING MACHINE.



CORNER OF ENGINE ROOM—DYNAMO AND SWITCHBOARD.

In the type of Tesla motor installed for the Farr & Bailey Co. there is neither brush nor commutator. The two-phase or three-phase alternating current supplied to the field magnets, sets up in the motor a rotating magnetic field which causes the armature to revolve, while the currents in the armature flow in closed circuits with no connection to any external circuit, so that sliding contacts are not used and sparking is impossible.

Messrs. Farr & Bailey are noted not only for their good judgment in estimating the value to them of improved methods of manufacture when they are proposed, as well as for their enterprise and boldness in adopting and applying them. When they were making the plans for their new factory, they resolved to substitute electric power for steam power, if possible, and thus get rid of the large number of steam engines, such as are scattered about in their old factory, with their long leads of steam pipe and the accompanying waste of power. The problem set for the electrical engineers was to provide an electric power system which should be absolutely free from sparking or flashing within the buildings, and equal to, or exceeding in efficiency, any other electric system in use, and capable of supplying at the same time current for electric lighting—incandescent lamps inside of the building and arc lamps out-of-doors.

The contract was given to the Westinghouse Electric & Manufacturing Co., of Pittsburg, who have installed a system that meets the conditions fully and is peculiarly well adapted to the purposes in many other ways.

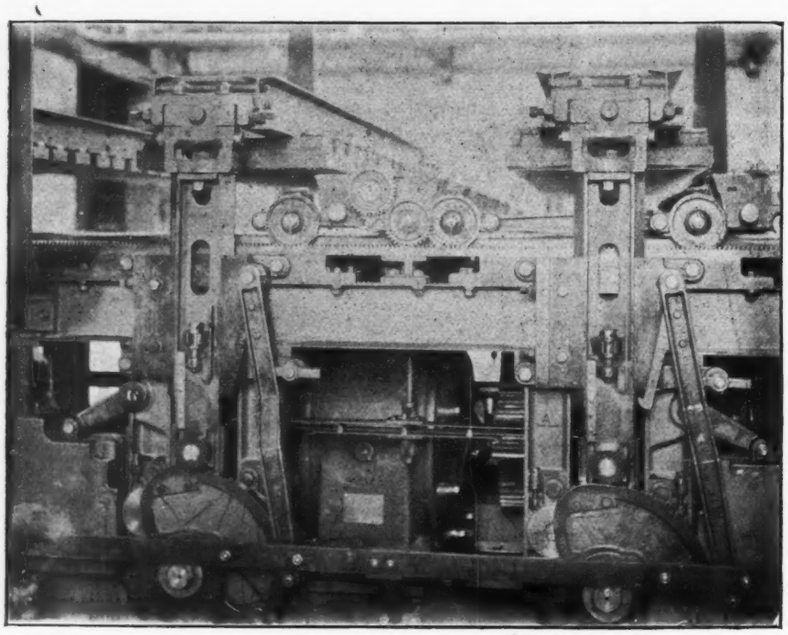
In the engine-room is placed a Westinghouse 60 kilowatt two-phase generator, with its exciter and switchboard, as shown in the photograph. From here the current is carried upon a short length of pole line to the main factory building. Advantage has been taken of the fact that the distances are short, and the generator has been wound for a low potential so as to avoid the use of high potential wires, and also to admit of distributing

current directly to the motors and lamps without the intervention of transformers.

Inside the building all switches, large and small, are immersed in a tank of heavy oil, which absolutely suppresses any spark that might be produced in opening a circuit, while all the incandescent lamps are inclosed in vapor-tight glass globes.

The most important machine in the manufacture of oil-cloth is the printing machine, a general view of which is shown in the photograph. The roll of unprinted cloth is fed into the machine at one end, and as it passes across the platform the large carriers, (each holding a printing block or die), shown in the photograph, move up and down simultaneously, each leaving on it an impression of a part of the desired pattern in its own peculiar color of paint, so that when the cloth arrives at the other end, the completed pattern appears as made up of many impressions in as many different colors as there are printing blocks. The operation is continuous, each die adding its part of the pattern, and while the unfinished cloth is passing in at one end of the machine, the finished product is being drawn into the drying racks at the other end.

This machine is driven by a 7½ HP. motor, set inside the frame and geared to the main shaft, as may be seen below, making a very compact and business-like arrangement.



PORTION OF MACHINE SHOWING MOTOR UNDERNEATH.

The drying of oil-cloth requires large stationary racks and a great deal of room, and as each drying rack becomes full, it is necessary to move the whole printing machine sidewise until it comes opposite to another rack. This is accomplished by having the machine mounted on wheels which run on accurately levelled tracks, the rails of which are set flush with the floor. To this end the current for the motor is supplied through a flexible cable, so that the whole machine may be traversed across the room without the necessity of breaking the electrical connections. It is started and stopped by means of a switch and starting device immersed in a tank of oil carried upon the side of the machine.

Other motors are used for mixing the paint, drawing the oil-cloth into and out of the drying racks, and for the large freight elevators. In the latter case reversing switches are used, worked from the car. Experience has shown that the motors have an abundance of starting power, three or four times the normal running torque corresponding to their rating, and that they may even be reversed while running at full speed, without injury.

By means of a simple induction device known as a balancing coil, the 110 volt lamps are operated from the 220 volt circuits at high efficiency, and without the inconvenience of connecting two lamps in series.

The whole electric plant is entirely satisfactory to the owners of the factory and reflects great credit upon the engineers who planned and installed it.

NOTES FROM A BRASS SHOP.

The Eynon-Evans Mfg. Co., of 15th and Clearfield streets, Philadelphia, Pa., have several interesting features in their plant. Beginning with the foundry, which by the way turns out about as nice brass castings as we have seen, there is much of interest. The foundry is served by a Ridgway steam-hydraulic crane, which not only handles the flasks in any part of the room, but also serves the furnaces, quite an improvement over the usual back-breaking and superheated method of lifting by hand.

The furnaces are set in the arc of a circle around the crane post, so as to be easy to serve, and are connected to a tall steel stack which gives the required draft. This can be regulated by a damper to suit the metal and the conditions of the atmosphere.

For ventilating the foundry and ridding it of obnoxious fumes, they have a plain disc fan suspended from the ceiling in the rear of the foundry, and it is said that it clears the smoke and gas out in a hurry, forcing it through an open doorway about 30 feet away.

In the grinding or "snagging" room a band saw is used for removing the gates from the casting or vice versa, in preference to the usual "chopping machine," commonly called a "sprue cutter," or circular saw. It is claimed, and apparently with good reason, that there is less liability of breaking pieces out of castings, especially thin ones, and that they can be trimmed more closely, leaving less finishing to be done. The advantage over the circular saw for cutting off small castings from a gate can be readily seen.

As an example of the work of this foundry, the writer saw bushels of small castings which would weigh considerably under an ounce apiece, as well as the plug for a 16 inch plug cock, quite a variation in size, as the plug was over 3 feet long and probably 24 inches across the largest diameter. It was to be covered with lead and used for acid work, and was the largest the writer ever saw.

* * *

THE well-known firm of Chas. Churchill & Co., Ltd., of London, Eng., announce that they have reorganized their company and increased the capital to £50,000 ($250,000). Of this, $150,000 has been subscribed for in fully paid cash shares; $50,000 has been allowed for good-will, and $50,000 retained for further issue when required. This firm has long been known as the leading dealers in American machinery abroad, and their increased capital will doubtless enable them to hold this position against increasing competition.

* * *

FLAT vs. "V" WAYS.

Although this is an old subject there is still something to be said, and when this comes from such an experienced mechanic as Supt. Derbyshire, of Bement, Miles & Co., it has considerable weight. The latest planers of this company have flat ways, which, as Mr. Derbyshire says, are easier to make right than the V's, and to keep right after they are made. In addition to this they require less power to run them, at least this has been their experience. One instance in particular will serve as an example:

A 42-foot planer, of a little larger capacity between the housings than the 36-foot planer which it replaced, takes about 15 per cent. less power to drive it. This is not guess work, for as the planer is driven by an independent engine, it was easy to determine the power consumed in each case.

Flat ways are easier to lubricate, less liable to cut (principally on account of the better lubrication), and they are certainly more easily planed true and kept true than the other forms, as remarked by Mr. Derbyshire. He also told the writer of a recent order for a lathe in which the purchaser laid particular stress on the fact that he wanted a flat bed, saying that a lathe he had bought years before with this form of bed, was in better shape than any other tool in the shop. It was still in line, the ways were not cut and it was in better condition generally.

Many will, of course, oppose this idea, but it is at least worth thinking over.

PATTERN FOR A CYLINDER CAM.

JOHN M. RICHARDSON.

The cam I am about to describe is that used for converting a rotary motion into a reciprocating one (within certain limits), and usually in a horizontal direction. These limits are governed by the pitch or throw of the cam, which has a groove along its face into which fits a roll, or pin, attached to a sliding bar in some form of guide.

To begin with, a good pattern-maker's lathe, with carriage and tool post, is an absolute necessity, for with an ordinary wood lathe, it would be next to impossible to construct the pattern in the manner described.

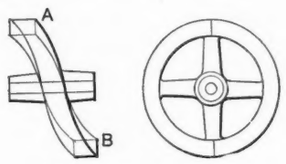


Fig. 1

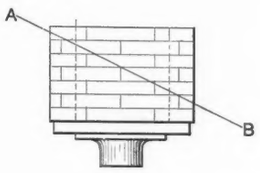


Fig. 2

For example I shall assume that a cam 10 inches in diameter and 5 inches throw is required, as shown in Fig. 1, and that the groove for the roll is milled in the machine shop, instead of being cast, which is a difficult matter on small sizes, and when done leaves so much sand in the corners, that a milling cutter is dulled many times worse than when cutting solid metal.

A plain drum of the proper diameter, having the same groove in its face, would produce the same result, as far as the required mechanical motion is concerned, but oftentimes this form is too clumsy and heavy, and the more graceful design with spokes, and rim of parallel thickness, is preferable.

The first thing to do is to get two face-plates ready, and commence sawing out segments; those built upon the first face-plate to be laid up as cheaply as possible, with thick layers, and poorer material, and those on the second of hard wood and thin layers, for the reason that what is done on the first face-plate is sort of a necessary evil, and is no part of the pattern proper, but simply a form on which to manipulate it while in the process of construction, and should be, perhaps, a couple of inches higher than the pitch of the cam. The work done on the second face-plate is to be the rim of the cam itself. This must be a much larger diameter of ring, with a smaller hole, and just thick enough to work out the rim easily.

The temporary form shown in Fig. 2 must now be cut across at A B, which can easily be done on the band-saw, by nailing a board across the end, having a width the same as the diameter

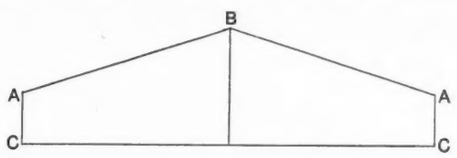


Fig. 4

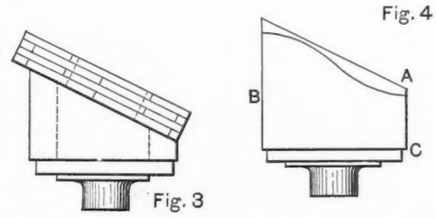


Fig. 3

of work, and fastening another one to the edge of this, cut on an angle, so as to form a guide to saw by. The first board mentioned will stop all liability of the work jumping, or turning when the saw strikes it.

The ring in Fig. 3 is now glued on firmly, and the outside sawed to conform with the outside of our form piece on the face-plate.

The tug of war now begins, for it is a slow job and requires great care to turn it, and it is a curious looking object bobbing around in the lathe, but if the carriage is firm, and the tool-post solid, there will be no danger.

The outside must be turned clear back to the face-plate, the diameter of the cam plus what is allowed for finish in machining, which should be about ⅛ inch. The inside will take somewhat longer to turn, for there is so much more stock to be cut away, and there is more danger of the tool catching.

After the turning is completed, take a piece of thick brown paper just long enough to pass around the piece and meet at the edges, then fold it carefully in the middle, and assume a length A C, Fig. 4, a little less than A C on the turned shell, and on the fold lay off a distance equal to the one just taken, plus the pitch of the cam, and lay a straight edge from this point to the point A, being careful to have the bottom edges just even, and then cut the paper with a knife. Next, open the fold and wind the paper around the work, as shown in Fig. 4, fastening it temporarily with a few small tacks, and with a very sharp point trace the line of curvature against the edge of the paper upon the work.

A form of sweep must next be constructed, similar to Fig. 5, with a vertical shaft perhaps an inch in diameter, at the base of which is a round block the exact diameter of the inside of the shell just turned. The cam ring must now be detached from the face-plate, and set in position over this block.

The sweep must fit the spindle so that it can be moved freely in any position to test the work, and yet not be loose enough to allow it to depart from its horizontal position.

Cut carefully to the line scribed upon the work, testing it with the sweep, and after this is finished remove the piece and gauge on the width or face of the cam from the edge just made, as

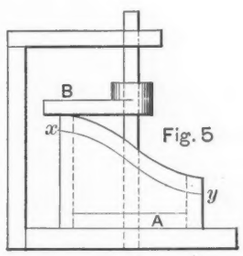


Fig. 5

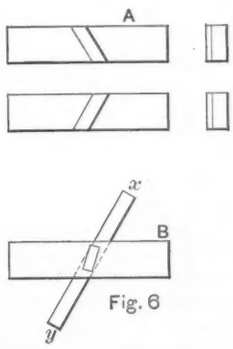


Fig. 6

shown by the dotted lines. Saw out roughly with a key-hole saw, and finish to the line, testing this time with a small try-square.

The rim is now completed, and the hub and spokes next demand our attention. It is easier to take two pieces for the hub, as at A, Fig. 6, and lay out the proper angle for the two arms not perpendicular to the rim, cutting half the width of arm in each and then gluing together. This hole is plugged temporarily and the mortise for the other arms made and plugged also.

A great deal depends on cutting the hub so that the arms will come to the exact place required when set into the rim, and the careful centering of the block for the turning is also very important. The piece is now to be placed in the lathe and turned to the right diameter and length, then removed, the plugs pushed out and the piece which forms the arms $x\,y$, Fig, 6, inserted.

Next cut through this arm where it covers the other hole, in the center of the hub, and push in the second piece with glue, which is to form the third and fourth spoke. Cut the arms as near as possible to the proper length, and then replace in the lathe, and with a very sharp tool in the tool-post, and a very fine chip indeed, dress down the ends until the arms at right angles to the hub are a length from tip to tip just equal to the internal diameter of the rim. The spokes look very odd indeed, flying around in the lathe, and will splinter badly unless care is used, for the cut comes across the grain and the piece is weak.

Next remove the piece from the lathe and work out the spokes to the required shape and fasten temporarily to the rim. Now replace in the lathe, and test the work by putting a long, straight rest into the tool post, bringing it close up to the work, and when the point A, Fig. 1, is just opposite, make a mark on the lathe-rest, then turn the work until the point B comes into the same relative position, and make another mark. Measure the difference between these two points, and if it exactly equals the required throw of the cam, then the work is perfect, if not the affair will have to be slightly adjusted before the spokes are fas-

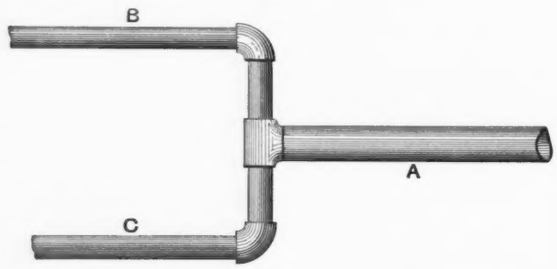
tened solidly to the rim, after which fillets must be added, and the sharp angles A and B, both outside and inside, where the turn occurs, should be softened somewhat. Now the pattern can be shellaced and finished, which of course requires no further description.

* * *

OIL IN BOILERS.

W. H. WAKEMAN.

A young engineer who had charge of two tubular boilers, found that No. 1 was badly coated with oil on both shell and tubes, while No. 2 was comparatively clean. What made the difference? Where did the oil come from? I will answer the last question first, by saying that the factory heated by these boilers was fitted up to use both live and exhaust steam for heating purposes, therefore the cylinder oil all went into the system, for there was no separator in the exhaust pipe to remove it. The water of condensation all returned to a brick cistern prepared for this purpose and was pumped back into the boilers.



This would indicate that there was no mystery about the oil in boilers; but why should one get nearly all of it, while the other was practically free from the troublesome stuff? An examination of the feed-pipe showed it to be arranged as shown in the illustration. A is the main feed pipe, B is a branch feeding No. 1, while C is connected with No. 2. As this is an elevation of the arrangement, it will be understood that as a larger portion of the oil rises to the highest point, it will go to No. 1, while a comparatively small amount will get into No. 2. Had it been arranged so that the illustration would have represented a plan view instead of an elevation, then both boilers would have had an equal chance to get a share of the oil. At times the oil would be so thick on the shell as to cause the joints to leak, because the water was kept from the iron by the oil.

Some men seem to think that the oil will always rise to the top, hence it can do no harm in a boiler, but this is a mistake, for after the lighter ingredients are disposed of, the heavy matter will settle to the bottom. I have seen a boiler so drenched with this oil that when the man-hole cover was taken off, it would drop from the tubes to the shell like molasses, and yet the proprietor would not purchase a separator.

Engineers who find themselves in charge of such plants should keep the cistern nearly full of water, because the suction pipe is taking it from the bottom, and the more water there is in the cistern, the quicker will the oil work up to the surface. Great care should be taken to wash out such boilers frequently, regardless of the inconvenience of it. The cost of frequently washing out boilers is an item for the proprietor to take into consideration when reported by the engineer, and is another argument in favor of a separator.

Writing of the numbers by which boilers are known, reminds me of the difficulty that some engineers seem to have in understanding what is meant in such a case. It seems to be a simple matter to take up, for when you go into a boiler room and stand facing the boilers, the first one to the left is No. 1, the next No. 2, and so on down, just as you follow the lines in reading a book, for this is the only natural way to number these.

* * *

ELECTRICITY ON FARMS.

The following description of an electrical plant in Mecklenburg, is from the report of Julius Muth, Consul at Magdenburg:

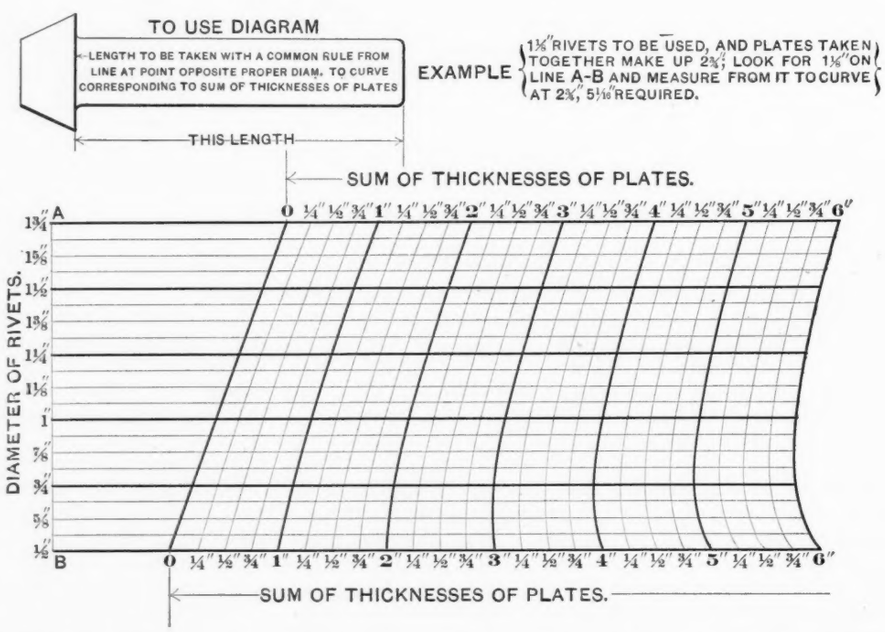
The motive power is furnished by a small brook, which passes the farm at a distance of about 650 feet and drives a turbine wheel. About 1,650 feet above the wheelhouse, a dam has been erected in the brook for the purpose of obtaining the necessary fall and forcing the water into a canal leading to the turbine. This canal is partly cut into the ground and partly banked, so that at the turbine, a fall of 5¾ feet is obtained. The volume of water changes from 18 cubic feet a second in very dry seasons to 106 to 141 cubic feet a second in very wet seasons. With an average of 35 cubic feet, the turbine is guaranteed to furnish 16 HP., while in reality it furnishes 18 and at high water 21 to 22 HP. The turbine drives a Schubert dynamo machine, which develops all the electricity needed. From this dynamo, the current goes to the so-called switch board, then to the various stations. There are 182 incandescent lights, besides two arc lamps. In the turbine house, there is also an accumulator. During the day, when the machines are not in operation on the yard, this accumulator is charged and will contain sufficient electricity to feed the lights from evening, after working hours, till the next morning. By careful handling, the accumulator has furnished sufficient electricity to last five days without being charged. There is said to be a saving of $285.60 per year over the steam plant formerly used. The difficulty with such comparisons is that we rarely know the details as to the condition of the former apparatus or whether it was in good order or not.

* * *

BOLTS, NUTS AND RIVETS.—2.

NUTS AND RIVETS.

It may not be generally known, even though it is not new, that the best nuts in every-day use are punched cold instead of being heated before punching hole. While this may seem a small matter, it has quite an appreciable effect on the strength of the nuts as well as on the taps used in threading them. Tests made a number of years ago show that the cold pressed nuts have a much greater (10 to 20 per cent.) resistance to stripping, and that having a perfectly clean hole for the tap to work on, the saving in taps is considerable, the exact saving being hard to specify.


TO USE DIAGRAM
LENGTH TO BE TAKEN WITH A COMMON RULE FROM LINE AT POINT OPPOSITE PROPER DIAM. TO CURVE CORRESPONDING TO SUM OF THICKNESSES OF PLATES
EXAMPLE
1⅛" RIVETS TO BE USED, AND PLATES TAKEN TOGETHER MAKE UP 2⅜"; LOOK FOR 1⅛" ON LINE A-B AND MEASURE FROM IT TO CURVE AT 2⅜", 5/16" REQUIRED.
THIS LENGTH
SUM OF THICKNESSES OF PLATES.
DIAMETER OF RIVETS.
A
B
0 ¼" ½" ¾" 1" 1¼" 1½" 1¾" 2" 2¼" 2½" 2¾" 3" 3¼" 3½" 3¾" 4" 4¼" 4½" 4¾" 5" 5¼" 5½" 5¾" 6"
1¾" 1⅝" 1½" 1⅜" 1¼" 1⅛" 1" ⅞" ¾" ⅝" ½"
SUM OF THICKNESSES OF PLATES.

The illustrations of rivets and the diagram, kindly furnished by the United States Naval Department, make much explanation unnecessary. There is little variation in these dimensions among rivet makers, and the sizes given are practically those in general use. In the cove-head rivet, the top of head is the same diameter as the body. The extreme length of countersink rivets

is always given, other styles are measured under the heads the same as with bolts. The shearing strength of rivets is often taken as about 90 per cent. of the tensile strength, other authorities take but 70 per cent., although this depends on the material in question. Rivets are usually put up in kegs containing 100 pounds.

The diagram for determining length of rivet for plates of varying thickness should be useful in many cases.

DIAGRAM FOR LENGTHS OF RIVETS.

(CONSTRUCTED FOR HOLES DRILLED 1/16" LARGER THAN DIA. OF RIVETS. MACHINE RIVETING. BOTH HEADS ALIKE.)

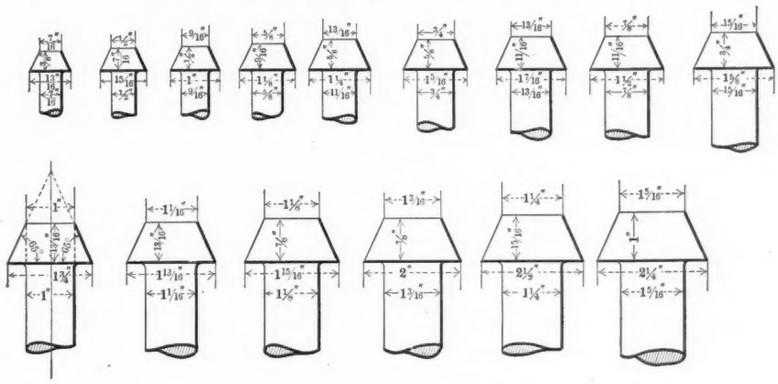
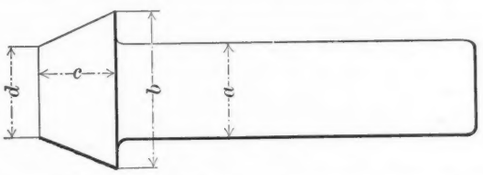


TABLE OF RIVET DIMENSIONS, UNITED STATES NAVY.



a	b	c	d	Weight of 10 Heads.
7/16 inch.	13/16 inch.	3/8 inch.	7/16 inch.	.331 lbs.
1/2 "	7/8 "	7/16 "	1/2 "	.531 "
9/16 "	1 "	1/2 "	9/16 "	.713 "
5/8 "	1 1/8 "	9/16 "	5/8 "	1.007 "
11/16 "	1 1/4 "	5/8 "	11/16 "	1.373 "
3/4 "	1 5/16 "	11/16 "	3/4 "	1.551 "
13/16 "	1 7/16 "	3/4 "	13/16 "	2.032 "
7/8 "	1 1/2 "	13/16 "	7/8 "	2.258 "
15/16 "	1 5/8 "	7/8 "	15/16 "	2.871 "
1 "	1 3/4 "	15/16 "	1 "	3.584 "
1 1/16 "	1 13/16 "	1 "	1 1/16 "	3.91 "
1 1/8 "	1 15/16 "	1 1/16 "	1 1/8 "	4.761 "
1 3/16 "	2 "	1 1/8 "	1 3/16 "	5.17 "
1 1/4 "	2 1/8 "	1 3/16 "	1 1/4 "	6.915 "
1 5/16 "	2 1/4 "	1 1/4 "	1 5/16 "	7 391 "

* * *

In response to numerous requests for some matter dealing with electrical machinery, we have secured a series of articles from a well-known electrical designer, Mr. Wm. Baxter, Jr., on the calculation, design and construction of direct current dynamos. These will be entirely different from anything in this line that has appeared heretofore, as they are written in simple language, and all the calculations are made without the use of any algebra whatever, by simply using the rules of ordinary arithmetic. This will be appreciated by all mechanics, who are sure to be deeply interested in these articles. We hope to begin the series in the June issue.

* * *

THE QUESTION OF LIGHTING.

One of the most important questions regarding the quantity and quality of work turned out by shops, is that of light. In cities, with high buildings all around, it is almost impossible to avoid the use of artificial light a great portion of the time.

One of the most simple, and to all appearances useful, inventions we have seen, is that of the Luxfer Prisms, which is an application of the principle of refraction. The glass is cast in four inch squares, one side having a series of saw-tooth ridges, or half prisms. With plain glass, the light strikes the floor very close to the window, and the rest of the room is comparatively dark. With these prisms the light is diverted and thrown back into the room; making such a difference in the amount of light as to almost astonish anyone. It is not claimed that light is created, only that light is diffused evenly throughout the interior.

In the New York exhibit of the Luxfer Prisms Co., at 24 Beekman street, a store 150 feet deep is very evenly lighted, and the basement is also fairly well lighted, although there is only 24 square feet of skylight prisms in use in the sidewalk. It is claimed that the deposit of dust on the top of ledges or prisms does not effect the light, as these are not the important surfaces.

The squares are mounted on a wooden frame, each square being held in a very ingenious manner. A copper ribbon is inserted between the squares and the whole then subjected to an electrolytic bath, which deposits copper in all the interstices between ribbon and glass, makes it practically one piece, and makes the whole thing waterproof.

It is evident that any device of this kind must effect a considerable saving in artificial light and be a direct economy in this way, as well as increasing the output by a better light. It is apparently one of the most practical devices that has been introduced for this purpose.

* * *

A READER writes: "Can you suggest any method for training the memory to retain formulas? I learn them; learn how to use them, and then—from not using them constantly—I forget them." The only way we know of remembering formulas is by constant use, or by a thorough understanding of the factors involved and their relation to each other. It is useless, however, to attempt to burden the mind with a mass of formulæ which may not be needed once in a year. The proper way of using reference books, is to become familiar enough with them to be able to find any rule you want, and to know how to use it after you have found it. It is well to practice using a formula which you think you may need at any time, so as not to waste time when the problem comes; but as for trying to memorize all the useful rules you come across—don't, it's wasted energy. A few may be able to do it, but it is neither wise nor necessary.

* * *

VALVE GEARS.—7.

E. T. ADAMS.

PORT OPENING AND AREA OF PORTS AND STEAM PIPES.

It has been assumed in the previous papers that these quantities were known. In designing an engine they must be computed, and while the rule given here will serve as a general guide, the results obtained by its use are often greatly modified for reasons of which the formula takes no account. Let a = the required area of port or pipe, as the case may be, in square inches, A = the area of the piston in square inches, V = the average velocity of the piston in feet per minute, and v = an allowable velocity for the steam when passing through the port or pipe which is being designed. Then

$$a = A \frac{V}{v}$$

A and V are known when the size of the engine and the revolutions per minute are known, v is given different values according to the type of engine and the judgment of the designer; but the values of v, as given below, are the average of values found at the present time in good practice. For a plain slide-valve engine, the average velocity, v, of the "live" steam should not exceed 8 000 feet per minute, and the average velocity, v, of the exhaust should not exceed 6 000 feet per minute. Now these figures are simply values which, all things considered, have seemed best under average conditions; they may be greatly modified to suit unusual conditions or special cases. By way of illustration we will use this rule to determine the size of the steam pipe for an 18 x 24 engine making 135 revolutions per minute. A = the area of a circle 18 inches in diameter = 255 square inches, V = the average velocity of the piston = 24 × 2 × 135 ÷ 12 = 540 feet per minute, then the area of the steam pipe,

$$a = A \frac{V}{v} = 255 \times 540 \div 8\,000 = 17\tfrac{1}{4} \text{ square inches.}$$

4½ inch pipe is the nearest regular size, the area of such a pipe being 16 inches instead of 17¼ as desired. In the same way we find the area of the exhaust pipe

$$a = A \frac{V}{v} = 255 \times 540 \div 6\,000 = 23 \text{ square inches.}$$

This falls between a 5 and a 6 inch diameter, the area of a 5 inch pipe being 20 square inches, and the area of a 6 inch pipe 29 square inches. There is no regular size between these two, and it is better to choose the larger value, making the exhaust pipe for this case 6 inches. These values are seen to correspond exactly with the common shop rule, "steam pipe = ¼ cylinder diameter," exhaust pipe = ⅓ cylinder diameter." Anyone taking the trouble to check this out will find that if the revolutions are increased by 15 turns, that is to 150 revolutions per minute, the size of steam pipe given by the formula will be 5 inches instead of 4½. These values of 6 000 and 8 000 as average velocities have been found sufficient in good practice under average conditions; they do not apply in any other case. For example, if the steam or exhaust pipe is either extra long or crooked, both pipes should be made larger, in fact wherever fuel costs anything a larger steam pipe will certainly be a good investment, as a larger steam pipe insures less "drop" in pressure between boiler and steam chest. Of course some "drop" is necessary; we never get something for nothing, and steam is not going to flow through a pipe unless work is done on the steam to make it flow. Now the larger the pipe the less the friction will be, and in consequence less work will be necessary to force a given quantity of steam from boiler to steam chest. The part of the "drop" not due to radiation is a measure of this work done on the steam, and it is evident that if we use a part of our available pressure or heat in overcoming the friction of a small steam pipe, there will be that much less energy available for use in the cylinder. This same reasoning will apply with equal force to other cases, as for example, to the loss due to friction in port passages and through the valves. We will come back to this again. In the usual case to which this rule applies, cut-off occurs at not far from ¾ stroke; if cut-off is to occur much earlier than this, a somewhat smaller pipe will answer. Again in the usual case, steam is used in this type of engine at not far from 80 pounds gauge pressure. Note that as the pressure is increased, the density of the steam is increased quite rapidly, and if the steam pressure is to be 100 pounds or over, then a larger pipe is called for, as the work done on the steam in forcing it along the pipe will increase as the density increases.

In general the values found by the rule should be taken as minimum values. The steam pipe should be large enough to supply the engine when at the maximum speed of which it is capable; this should be considerably greater than 135, and when working at full load with cut-off at ¾ or ⅞ stroke, and the exhaust pipe should be large enough to allow the exhaust to escape without undue back pressure.

The ports and port passages may be designed by this same rule. In a plain slide-valve engine the same port serves for both steam and exhaust, and the area of the port must accordingly be great enough to allow the passage of the latter. The engine we have just been considering is very likely to be run at a greater speed than 135, and in designing the ports we will assume that this speed is 150 revolutions per minute. The average velocity of the piston V will now equal $150 \times 2 \times 24 \div 12 = 600$ feet per minute and the area of each port

$$a = A\frac{V}{v} = 255 \times 600 \div 6\,000 = 25\tfrac{1}{2} \text{ square inches,}$$

which is the same as the common shop rule for this type of engine, "Area of port = $\frac{1}{10}$ of the area of cylinder." If the piston speed is greater the area of the port should also be made greater; if the ports are long and crooked, greater area is necessary than when they are short and direct, but when the ports are long the clearance is already great and the tendency is to reduce the area in order to lessen the clearance; it is the better plan, however, to keep the port area fully as large as given by the rule. When the clearance is already 10 or 12 per cent., a change in the clearance of 2 or 3 per cent. either way has very little effect on the economy of the engine, while insufficient port area is certain to cause a great loss of efficiency. This brings us back for the second time to the loss due to "wire drawing"; it will be found that this comes up at every step in this part of the design of a valve gear.

Given an area of 25½ square inches, either the width or the length of the port must be assumed; it is usual to assume the length which in engines of this type is made, anywhere between length = ¾ diameter to a length equal to or even greater than the diameter, the greater length is supposed to favor a sharper opening and closing of the valve, as a given movement of the valve opens up a greater area of port, but on the other hand, the liability to leakage is greater and the loss, due to "wire-drawing," is greater; and unless the engine has been carefully selected, so that it will run at full load all the time, very sharp opening and closing of the valve is of comparatively little consequence, as the steam will be throttled by the governor in any event. Merely adding to the length of the valve does not have any effect on the sharpness of cut-off if the port-opening is made a fixed proportion of the width of the port, and the better way to secure this effect, if it is desired, is to choose a moderate length for the valve—one giving ports which are not too narrow—and then to secure the degree of sharpness of cut-off desired by increasing the travel of the valve. If the length of the port is made 14½ inches, a width of 1¾ inches will give the required area of 25½ square inches. The port passages may well be increased to 2 inches by 14½ inches, to allow for crooks and rough surfaces.

PORT-OPENING.

The exhaust port-opening must, at least, equal 1¾ inches. The sharpness of opening and closing of the valve will be increased if the steam port-opening is also made 1¾ inches, but this involves increased size of the valve and this means increased friction, hence in plain slide-valve engines the steam edge of the valve does not usually fully uncover the port. To come back to the rule, the area of the steam port opening, a, $= A\frac{V}{v} = 255 \times 600 \div 8\,000$ = 19 square inches nearly, and $19 \div 14\frac{1}{2}$, the length of the port, = 1⅜, which, with a small error on the right side, is the required width of port-opening. Knowing the width of the port, the steam port opening could have been found more simply, for since the velocities of steam and exhaust are respectively 8 000 and 6 000, the steam port opening is just ¾ the exhaust port opening. The reader will do well to check the computations made so far, and taking the port opening just found, find the steam lap for an average or nominal cut-off at ¾ or ⅞ stroke. Assume for this purpose that the lead is 1/16 inch; next, draw an indicator card taking 10 to 12 per cent. as the clearance and 80 to 90 lbs. gauge pressure for steam. No values are given for either release or compression, but one at all familiar with an indicator card, can, after a few trials, get a satisfactory value for the exhaust lap, and the card may then be completed.

Almost every step in proportioning the ports and passages bears in some way on the effect of "wire-drawing" the steam, that is, of admitting the steam through a restricted opening, causing a reduction of pressure due to friction. It is possible here to get into an interesting problem in thermodynamics, but for our purpose which is to bring out the reasons which influence one in such matters as, for example, choosing the length of port, it may be considered very simply. Take, for example, the port that we have just been considering, its area was 25½ square inches, in order to force steam at 80 lbs. pressure through this area at the average rate of 8 000 feet per minute, work must be done, partly to give the steam this velocity but almost entirely to overcome the friction between the steam and the walls of the passage. This work takes a certain amount of energy, and coal must be burned to supply it. If the heat, generated by the friction, all remained in the steam, producing superheated steam, there would be no loss, but this is never the case; steam is admitted to a port which has just been cooled down by contact with the exhaust, and the metal wall of the cylinder and the water in contact with it, absorb the greater part of the heat, indeed the iron would still absorb the greater part of the heat generated by this friction if iron and steam were at the same temperature, since the iron is a better conductor of heat than superheated steam, part of this heat is radiated to the exhaust passage and a part is retained by the wall and given up after release to the exhaust as it is forced through the same port by the return stroke of the piston. But, granted that my statements are true, and that there is a loss due to "wire-drawing." We may reduce the amount of wire-drawing, and the consequent loss by reducing the friction, and finally, the friction may be reduced by reducing either the velocity of the steam or the area of the surface with which it is in contact First, as to the area, if instead of 1¾ inches we had made the port but ½ inch wide, the length to give the required area would need to be 51 inches and the distance around any cross-section of the port passage would be 103 inches, on the other hand, it would be only 20 inches around

a port of equal area and 5 inches wide, and, in the last case, the surface exposed to friction would be not far from 1.5 as great as in the case first considered. Unfortunately, 5 inches of port opening means about 5 inches lap and 20 inches travel to the valve; consider the length of steam chest necessary, and the size of the eccentric! The valve chosen 1¾ ✱14½, was simply the writer's compromise between excessive area exposed to the friction of the steam and excessive valve travel. The port passage was enlarged to two inches. This did not reduce the distance around the cross-section of the port, as the length of this port was the same as before, but the increased area tended to reduce the velocity and so to reduce the friction. This is the way the gain is made when using large steam and exhaust pipes, the velocity is less and consequently the friction is less.

It should not be forgotten that there is an action analogous to wire-drawing going on in the exhaust pipe, only instead of causing a *drop* in pressure, it causes a *rise* in the back pressure, as the lower limit of pressure (atmospheric) is fixed, and wire-drawing of the exhaust, unlike that on the steam side, has no redeeming feature; *all* the energy expended in this direction is wasted.

* * *

BEGINNING with the April issue, *Electrical Engineering*, of Chicago, will be issued semi-monthly, at the same price as before, one dollar per year.

* * *

MECHANISM FOR MECHANICS.—3.

PROF. CHAS. H. BENJAMIN.

TWO CRANKS CONNECTED BY A LINK.

The point B in Fig. 6 (last issue), instead of moving in a straight line, may be attached to another crank and consequently move in a circular arc as shown in Fig. 7. One of the cranks may be called the driver and the other the follower or driven.

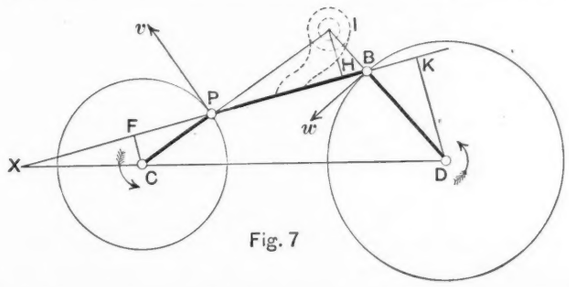


Fig. 7

In this combination the longer crank D B usually does not make a complete revolution, but oscillates through some angle depending on the lengths of the various parts, and is then called a rocker or sometimes a bell-crank. The method of determining this angle will be shown later.

Here, as in Fig. 6, the speed of the point B will vary continually if C P turns with a uniform velocity, but as B now has an angular motion it is necessary to find its angular velocity at any instant compared with that of the point P. This is called finding the angular velocity ratio of the cranks D B and C P.

Let a = angular velocity of C P.

Let b = angular velocity of D B.

Then $\frac{b}{a}$ = angular velocity ratio of D B to C P.

In Fig. 7 let C D = 10½ inches.

C P = 3 "

D B = 4 "

P B = 5½ "

Let the lines P v and B w represent the velocities of P and B at the instant in question and let us call them v and w. Produce the cranks C P and D B until they intersect at I; then by the same reasoning as that used in Fig. 6, I is the instantaneous center of the link P B, and its motion at this instant is the same as if it were actually revolving about I.

But we have already seen that when a body is revolving about a center the velocities of different points in the body will be proportioned to their distances from that center. Consequently the velocity of B will be as much less than that of P as I B is less than I P, or in figure:

$$\frac{w}{v} = \frac{\text{I B}}{\text{I P}} = \frac{2}{5} \text{ (measured)}$$

(The scale of the cut is $\frac{1}{8}$)

We wish to find angular velocities, and angular velocity is equal to the linear velocity divided by the radius, or:

$$a = \frac{v}{\text{C P}} = \frac{v}{3}$$

$$b = \frac{w}{\text{D B}} = \frac{w}{4}$$

$$\text{and } \frac{b}{a} = \frac{w}{\text{D B}} \div \frac{v}{\text{C P}} = \frac{w}{v} \times \frac{\text{C P}}{\text{D B}} = \frac{3w}{4v}$$

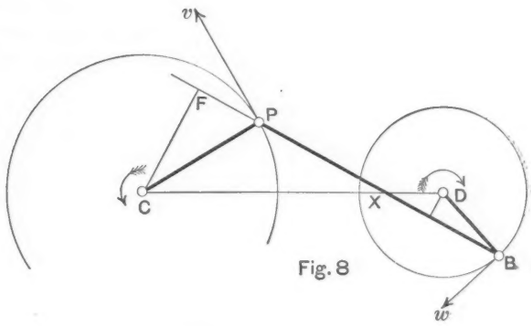


Fig. 8

Substituting value of $\frac{w}{v}$ from (a),

$$\frac{b}{a} = \frac{\text{I B}}{\text{I P}} \times \frac{\text{C P}}{\text{D B}} = \frac{\text{I B}}{\text{D B}} \times \frac{\text{C P}}{\text{I P}} \text{ - - - - - - } (b)$$

$$\text{or } \frac{b}{a} = \frac{2}{4} \times \frac{3}{5} = \frac{3}{10}$$

In the figure produce the line of the link at each end and drop upon it the perpendiculars C F, I H and D K. Then is the triangle C F P similar to the triangle H I P, similar sides being parallel and in like manner the triangle D K B is similar to H I B. Therefore:

$$\frac{\text{C P}}{\text{I P}} = \frac{\text{C F}}{\text{I H}}$$

$$\text{and } \frac{\text{I B}}{\text{D B}} = \frac{\text{I H}}{\text{D K}}$$

Substituting these values in (b) we have:

$$\frac{b}{a} = \frac{\text{I H}}{\text{D K}} \times \frac{\text{C F}}{\text{I H}} = \frac{\text{C F}}{\text{D K}} \text{ by measurement. - - - (8)}$$

C F = 1 and D K = 3⅓, $\frac{b}{a} = \frac{1}{3\frac{1}{3}} = \frac{3}{10}$ as before.

Expressing this principle in words: *The angular velocities of two cranks connected by a link are inversely as the perpendiculars dropped from the centers to the line of the link; i. e.,* at this instant C P is turning three and one-third times as fast as D B.

In Fig. 8 are shown two other cranks in a different position, but illustrating the same principle. Equation (8) will apply directly to this figure as well.

$$i.\ e.\ \frac{\text{ang. vel. of D B}}{\text{ang. vel. of C P}} = \frac{\text{C F}}{\text{D K}} = \frac{4}{1} \text{ by measurement,}$$

or in this case D B is turning four times as fast as C P at the instant.

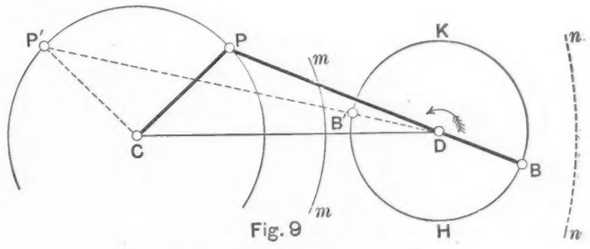


Fig. 9

DIRECTION OF ROTATION.

It will be noticed that in Fig. 7 both cranks turn in the same direction, while in Fig 8 they turn in opposite directions. From this it may be seen that: *When both centers are on the same side of the link the directions of rotation are the same; when*

the two centers are on opposite sides of the link, the directions of rotation are opposite.

In Figs. 7 and 8 denote the point of intersection of the line of the link with the line of centers by X. Then, as the two triangles C F X and D K X are similar, we have:

$$\frac{C\,F}{D\,K} = \frac{C\,X}{D\,X}$$

Substiuting this value in (8):

$$\frac{b}{a} = \frac{C\,X}{D\,X} \quad \text{- - - - - - - - - - - - - (9)}$$

We have then another method of finding the angular velocity ratio, which may be thus expressed: *The angular velocities of two cranks connected by a link are inversely as the segments into which the line of centers is divided by the line of the link.* Either of the methods may be used according to which is the more convenient, but it must be remembered that the ratio is continually varying, and that either method merely gives the value of the ratio for that particular position.

DEAD POINTS

Referring again to Fig. 8 it will be noticed that if the crank D B be used as a driver and turned continuously in the direction shown by the arrow, that the other crank C P will have a motion back and forth and cannot make a complete revolution.

In Fig. 9 are shown the two extreme positions C P and C P^1 of the second crank. This crank vibrates through the arc P P^1 and the points P and P^1 are called the *stopping points*, while the corresponding points B and B^1 on the other circle are called the *dead points* of that crank; and a dead point on one crank means always a stopping point for the other crank.

It will be noticed that in both of these positions the link and the crank D B are in one straight line, and therefore we may say:

A dead point is such a position of a crank that it lies in the same straight line with lhe link.

It can readily be seen that in Fig. 9 it would not be practicable for the crank C P to drive, as in either of the positions shown it could not turn D B at all. In other words, if dead points occur on the circle of the follower the motion is useless unless some form of fly-wheel is employed on that shaft.

Referring again to Fig. 9, let the length of the link P B = 11 inches, the length of the cranks C P and D B = 4½ and 3 inches respectively, and the length of the line of centers C D = 10½ inches. It may be seen from the figure that:

P D = 11 − 3 = 8 inches.

P^1 D = 11 + 3 = 14 inches.

Hence to find the stopping points of the follower, with the center of revolution of the driver as a center and radii equal to the sum D P^1 and the difference D P of the lengths of link and driver crank, describe arcs intersecting the circle of the follower, as at P and P^1. These points will be stopping points and from them may be found the corresponding dead points B and B^1 by drawing the straight lines P^1 B^1 D and P D B through the center D.

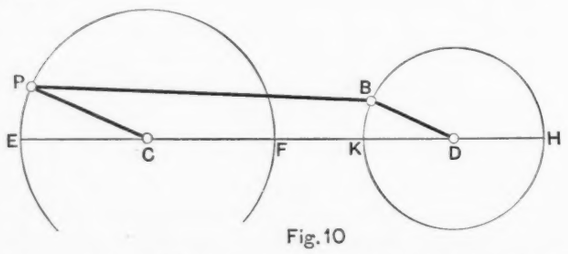


Fig. 10

The smaller crank circle may be tried for stopping points in a similar manner by using the center C and radii = 11 + 4½ = 15½ inches and 11 − 4½ = 6½ inches. In the particular case shown in Fig. 9 it will be found that the arcs thus drawn do not intersect the circle of B, but fall outside at *m m* and *n n*. This proves that there are no stopping points on the circle of B, and consequently no dead points on the circle of P.

In Fig. 10 if the link P B were made of the length K E or

10½ + 4½ − 3 = 12 inches,

there would be dead points for both cranks at the same time at K and E, and the motion would be unreliable, since with B turning, P might go either way. In a similar manner if the link were made of the length F H, or:

10½ + 3 − 4½ = 9 inches.

there would be dead points at the same time at F and H.

In order therefore to have the motion of the follower satisfactory, it is necessary that the length of the link should be between the limits K E and F H, or in words.

The length of the link should be *less* than the line of centers plus the difference of the cranks, and *greater* than the line of centers minus the difference of the cranks.

SLOW ADVANCE AND QUICK RETURN.

When continuous turning of one crank produces a back and forth motion of the other, as in Fig. 9, it is often desirable to have the motion of P slow in one direction and fast in the other, as, for instance, when P is used to drive the tool slide of a shaper. In Fig. 9 it will be seen that the arc B K B^1 is greater than the arc B^1 H B, and consequently if D B turn as shown by the arrow

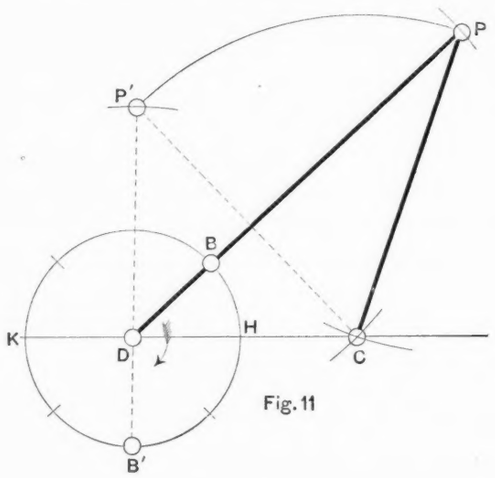


Fig. 11

at a constant speed, more time will be consumed by the follower in going from P to P^1 than during the return from P^1 to P. Within certain limits this difference may be made as great as desired.

Let it be desired to have time of return ⅝ of the time of advance, and let D B = the radius of the driver crank, Fig. 11. Divide the driven circle into eight equal parts and let the arc B H B^1 have three of these parts and the arc B^1 K B have the remaining five.

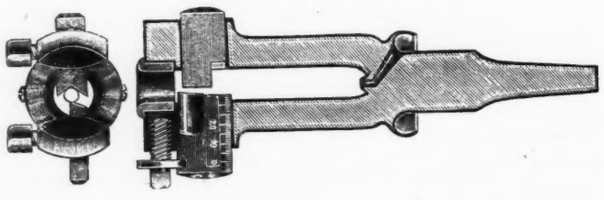
Then will B and B^1 be the dead points of the driver. Produce D B to P, making B P = desired length of link, and produce B^1 D to P^1, making B^1 P^1 = B P; P and P^1 will be the stopping points of the follower. With the desired length of follower crank as a radius and P and P^1 as centers, describe two arcs intersecting at C; then will C be the center of the follower. With B turning as shown by the arrow, B would turn to B^1 and consequently P to P^1 in three-fifths of the time required for turning from B^1 through K to B.

This is not so convenient a form of quick return motion as some that will be shown later.

* * *

A HOLLOW MILL.

Der Metalarbeiter shows the following from of a hollow mill which is used in the Gaishammer machine shop of Kaiser, in Nuremburg, and which is said to be patented. The tool is evidently designed to be used in a vertical machine, as the oil-way indicates. But one knife is used, as shown, and it can be adjusted



through quite a range of sizes. A scale shows the amount of adjustment and enables it to be set accurately without difficulty, as well as both the cutter and guide being locked solidly in place by means of the set screws shown. It shows considerable ingenuity on the part of the designer.

PISTON PACKING.

F. F. HEMENWAY.

In the earlier days of steam engineering, pistons packed with hemp, or some similar substance, were universally employed, a type that soon became common being represented in Fig. 1. As will be concluded, in order to compress this packing and set it out as occasion required, it was necessary to remove the cylinder head. To avoid this, Woolf made each of the adjusting screws terminate in a pinion, there being five of these screws, with a larger connecting toothed wheel at the center, the arrangement being such that by uncovering a hole in the cylinder head one of the screws could be turned, the turning of which turned all the others, thus adjusting the follower equally.

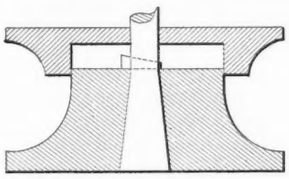


Fig. 1

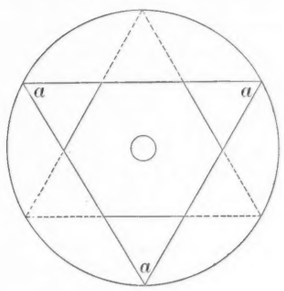


Fig. 2

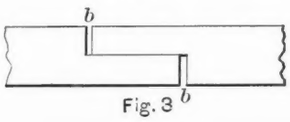


Fig. 3

So far as I know, the first metallic packing for the piston of a steam engine was made by Cartwright, just about one hundred years ago. This packing, as I have seen it represented in an old book, was, according to the author, something like Fig. 2. Making allowance for some crudeness in his sketch, and for his slight uncertainty in the matter, this packing evidently had the merit of being heavy enough for its purpose. It consisted of two rings, side by side, which we are informed were "accurately fitted." These rings were cut in three segments each, that "broke joints," as is plainly enough indicated. Three helical springs were employed for each ring, one end of which abutted against the piston-rod and the other at the joints where the rings are cut apart, as at *a*, thus forcing them out against the bore of the cylinder. It will be seen that Cartwright's packing covered at least one point very well, that was breaking the joints between the two rings. Its weight, if the author was substantially right in his sketch, would not be so objectionable in the instance of his vertical engine as it would be in a horizontal engine.

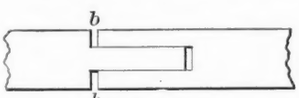


Fig. 4

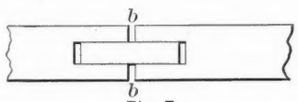


Fig. 5

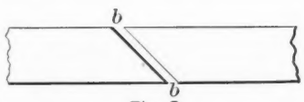


Fig 6

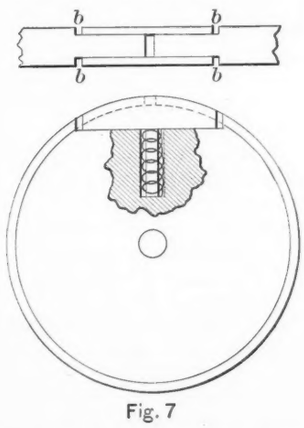


Fig. 7

Since Cartwright's day, the efforts to make a metallic packing that should be unobjectionable in use have been altogether too numerous to follow. Single rings were early tried, with all manner of efforts to prevent steam blowing through the cut. One plan, still in some favor, is indicated in Fig. 3, another in Fig. 4, and still another, with a separate tongue piece, in Fig 5. Examples might easily be multiplied if essential. Sometimes one ring only, at the center of the piston, is employed; sometimes, and generally in more modern practice, two—one at each end, the packing in either case being termed single ring packing. Whatever may be the practice in this respect, it is evident that unless the piston bears fairly against the cylinder at the cut, steam will find its way through the corners, as *b*, Figs. 3, 4 and 5, passing under the packing and so past the piston. It is hard to see why the greater complication, or, at least, the greater amount of labor involved in fitting the rings, as in Figs. 3, 4, and 5, or in other more complicated ways, makes them better to any measurable extent than cutting them, as shown in Fig. 6. For horizontal or slightly inclined cylinders, for which this packing is adapted, the cut being at the bottom, or at least in the lower quarter of the circumference of the cylinder, the corner previously referred to is very well protected through the action of gravity on the piston, which is all that will protect the more elaborately-fashioned joint. This may, perhaps, be more clearly seen by an examination of Fig. 7, which indicates the construction of a type of packing at one time quite extensively used. It is evident that this packing would leak a little more freely than that shown by Fig. 6, because there are more corners (*b*) for leakage, if the joint is not at or near the bottom of the cylinder. In fact, it is quite evident that when the joint is otherwise located, neither 6 or 7, nor even 8, will be absolutely tight, 7 being probably the most objectionable in this respect.

Fig. 8 represents a type of packing much in use at one time, and still considerably in evidence. One objection to it is the cost of fitting up; another that it requires a good deal of attention. The rings—there are three of them as shown, each being cut but once—require to be accurately scraped, one to the other, as well as to the follower and piston flange, at least, it is assumed that they do, and in all respects it requires the very best of workmanship. The packing, along with the body of the piston, forms substantially a solid adjustable piston. This packing entailed a good deal of work in the way of "setting out," as the frequent re-adjustment of the springs was called. Although an excellent packing, if well made and properly adjusted, its original cost and the cost of maintenance is too great for these days.

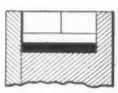


Fig. 8

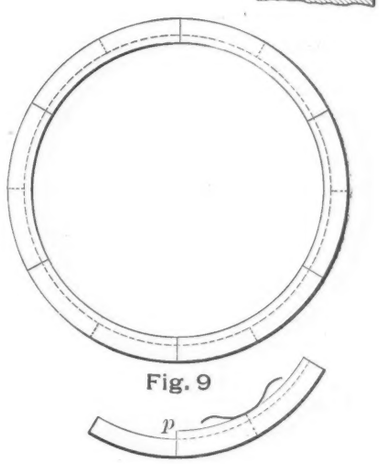


Fig. 9

For packing the pistons of vertical engines, such as tug-boat engines and the like, I never saw anything better than the original Dunbar packing, with some little modification. More than thirty years ago Dunbar made the circuit of the country, introducing his packing. He went right into a shop and took hold of the tools of his trade, wrestling out packing and pistons in a way that has never ceased to excite the reminiscent admiration of those who saw him at his work. He got right at what he was doing, like a mechanic who knew what a job should be, knew when it is good enough, and what he did went right; no scraping or grinding about Dunbar's work; went right together the way it left the lathe.

This packing, as I first knew it, was about as shown in Fig. 9, that is, the two sections that constituted a ring were kept entirely distinct, a single dowel pin keeping them in their correct relative position to break joints. The light springs that were required to hold the rings in position were of steel wire, bent around the "bull ring" and inserted under the packing rings. Through both the follower and the flange of the piston holes were drilled to admit steam under the packing to force it outward. The modification referred to was to rivet together the two sections, so that in detail they appeared as at *p*, Fig. 9, and for the bent wire springs to substitute springs as indicated. This, and entirely omitting the holes through piston and follower, constitute the principal modifications referred to. The broken section

above Fig. 9 represents this packing as applied to a solid piston, that is a piston in a single piece, which may very well be the case in the instance of a vertical engine. For a horizontal engine it is advisable to use a bull ring, or a T ring, as it is sometimes called, by the adjustment of which the piston may be centered.

The Dunbar packing was essentially a steam setting packing, and in the instance of an engine in which the pressure was materially reduced as between the beginning and termination of the stroke, the degree of intensity with which the packing was forced against the cylinder fluctuated, being materially the greatest in each end of the cylinder, alternately. The tendency of this was to wear the cylinder largest at the ends. The omission of the holes was for the purpose of preventing too free admission of steam to force the packing out at and near the beginning of the stroke; in other words, to modify the fluctuation of pressure under the packing operating to that end. The omission of the holes mentioned was in the direction of doing this. Riveting the sections together as shown, assured the requisite breaking of joints between them. The wire rods used for springs were thought to be objectionable, hence the springs as shown.

I am aware that the Dunbar packing, modified as referred to, was open to the objection of, to a lesser extent, wearing the bore of the cylinder larger at and near the ends; but this was of slight consequence. A new set of packing, should one be required, would very quickly accommodate itself to this irregularity, so that everything went on as if the bore of the cylinder was absolutely straight. Re-boring the cylinder because of irregular wear from the use of Dunbar packing, was something seldom or infrequently heard of. As intimated, I believe it to be by all means, the best packing for vertical cylinder engines ever devised.

At the beginning of this, reference was made to the use of hemp-packed steam engine pistons. Of course, no one would countenance the use of such pistons at the present time. It is, however, no more than fair to state that there may possibly be some other reason than the growing employment of steam of high pressure for bringing hemp-packed pistons into disrepute. In a work published in Germany in 1843, Dr. Ernst Alban instances engines of his own construction, with hemp packing, that had been in operation six months, the pressure being six to eight atmospheres, and the packing in that time showing not the least sign of decay. At that time, although being the inventor of "two metallic pistons" he strongly gave the preference to hemp-packed pistons for high pressure steam.

* * *

LIGHTING THE SHOP.—2.

HERBERT PRATT.

In starting a new dynamo (or an old one, for that matter), with a new set of carbon brushes, great care must be used to get a good fit on the commutator. The easiest way to do this is to get a sheet of No. 0 sand paper that will cover the whole commutator. The ordinary squares to be had at the hardware stores are much too small, but you can get it from any modern planing mill, as they buy it in rolls and will generally accommodate you. If you can't get the No. 0 in sheets, it will do no harm to use as coarse as No. 2, but would not advise using any coarser grade. Get your sand paper longer than the circumference of the commutator so as to be able to make a lap joint; by working carefully you can split the paper so that the joint will be the same thickness as the rest, and this is very important. The lap should be made so that when the machine is revolved the brush will smooth it down, instead of catching this lap, which should be glued. At the time you glue the lap, put a little glue on the commutator to keep the paper from turning. Then revolve the machine slowly with all the brushes removed from the commutator, and bring them to bear—one at a time—grinding each brush till it fits. If you are careful and bring each holder to the same position while grinding, you will find, after removing the sand paper, that they will come to line nicely as you set them. It takes but little more time to grind brushes this way than it does to tell it, but if you cannot get this roll sand paper, and have to wear them to a fit, you have a very dirty job but one that can be done if you are patient. In this case, the best way to proceed is to cut your sand paper the width of the brush, then take each brush separately, set it as well as possible, then place your sand paper between commutator and brush and draw sand paper the way commutator is to rotate; draw it clear out and be careful to keep it pressed down on commutator, as you want a good fit. Don't try drawing your paper back and forth, for there is usually enough play between brush and holder to allow it to work a little and this would round off the edges, preventing a good fit. Unless you get a good fit, you may be sure your machine will spark and heat, for the best designed machine I ever saw needed its brushes well ground in.

After getting the proper fit on the brushes, set them and adjust the tension. There is no rule that I can give that will enable you to do this exactly, but it should be as light as possible and still not so light that the brush will jump when the machine is running. If you are not used to setting them, it will be well for you to experiment with them on light load, and give them just enough tension to prevent sparking. After starting, watch your commutator closely, as if you have any trouble, it is likely to show there. The commutators that are built now, will stand a great deal of heat before any damage is done, but you do not want to let it get so hot that it will melt the solder used in the connections and throw it around the room. Your commutator should not get hot enough for this if your brushes fit well and do not have too much tension, but if it heats, it will be well to find out whether it is friction or current that causes the heat, so as to know what remedy to apply. Run the dynamo awhile with the brushes down but the field winding open, and note the rise in the temperature due to friction alone. It may be that all the trouble is here and if so, you will have to use less tension or else use something to lubricate the brush. If the machine runs without heat when not generating, then try it with a light load and note rise in temperature. If it now heats much more than it did before, it is best to look over your brushes and see that they are not set so as to make contact with too many segments, the correct number depending on the design of the machine. One brush set slanting ahead and another slanting back on the same stud, would give the same effect as too thick a brush. If your commutator does not heat on a light load, and does on a full load (brushes on neutral point in each case), it would indicate either that there was not enough carbon in the brushes to carry the current, or that they did not get a good bearing. As the machine has probably been tested before it was shipped, it is quite likely your brushes do not fit well. Make sure that they do before you complain to the company who sold you the machine.

Very often in starting up a new machine, it will be found that it has lost its magnetism and will not generate. If you have another dynamo near, this is very easily remedied. If your two machines are connected to the switch-board to run in multiple, all you have to do is to raise the brushes on the new machine so that they make no connection with the commutator, then start the old dynamo and throw both the main switches on to the buss bars. These will only have to be closed a moment, and if the machine was rightly connected to switch-board, it will be found magnetized right now.

If your machines are not connected to the same switch-board, you will have to run a pair of small wires to the old machine to the new one and connect them to the field terminals, being very careful not to connect them to armature terminals at the same time, to prevent the short circuit that would occur if you did. It is well to keep your brushes raised while you are magnetizing the machine.

If you have no other dynamo handy, then this complaint is more difficult to remedy and you will have to get a battery, and it is a hard thing to say how much of one you will need, as some machines will pick up much more rapidly than others, but you will need possibly 10 cells, which in most cases you can borrow from the local telegraph or telephone company. Another way to magnetize the machine if you have an arc light near your place, is to run two wires to the nearest lamp and shunt the current from lamp to machine, this will give you about fifty volts and will be sufficient. If you are going to do this, it is better to go to the electric light company and get their consent, if not their man to do the work.

After getting the machine to generate, it is well, if it is a compound machine, to find out at once whether you have the series and shunt coils working together. We will say your machine is wound for 110 volts at no load and 112 volts at full load; then, as your load goes on, your voltage should rise—the speed of course being constant. If the voltage rises, you may be sure the series

coil is working so as to help the shunt as it should, but if, on the other hand, the voltage goes down as load goes on, don't lay it to the series coil till you see that your speed is constant; if it is, then you may know your series coils are working against the shunt windings. In this case you will have to reverse the machine, and to do this it will be necessary to treat the machine as though it had lost its magnetism, for you want to magnetize it exactly opposite from its present polarity. Take a compass and see which is the north and which is the south pole, and then magnetize it so as to reverse the positions of these. You will then find your machine builds up all right and that the voltage increases as the load is thrown on.

* * *

MAKING TUYERES—BRONZE OR COPPER.

PHIL PASTRE.

Fig. 1 is a sketch of a tuyere, showing the thickness of metal, and other dimensions. They are used in the blast-furnace, are double walled and closed at both ends (with the exception of the four openings at the butt); they are also cast in one piece.

When made in an ordinary flask it is almost impossible to get a good casting; therefore we had to find some better way to make them, and Figs. 2, 3 and 4 show how they are made.

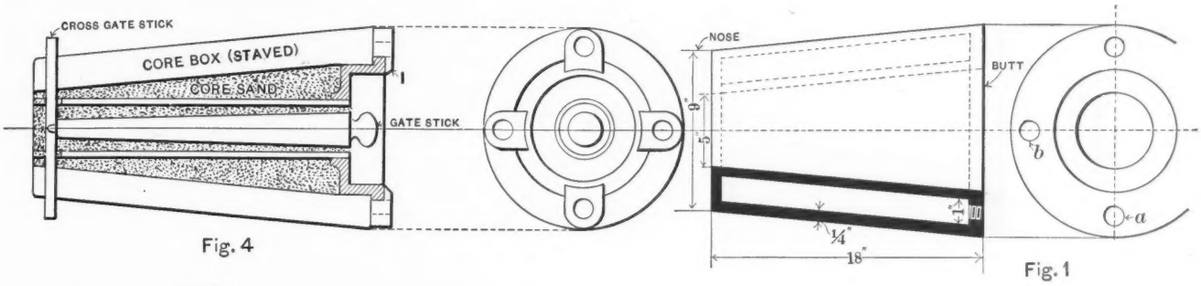


Fig. 4 Fig. 1

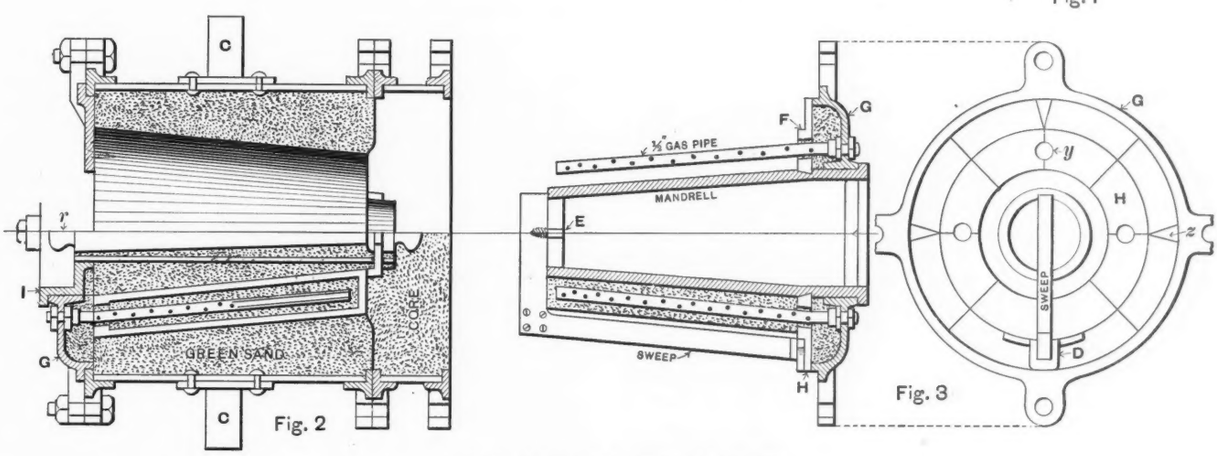


Fig. 2 Fig. 3

MAKING TUYERES—BRONZE OR COPPER.

These tuyeres are from 10 inches up to 36 inches long, and are from 10 inches up to 24 inches in diameter at the butt, though seldom over ¼ inch thick. This is a very difficult piece of work for the molder, as he is not allowed to use chaplets (or anchors).

The flask is made of ¼ inch boiler or sheet iron, perforated with ½ inch round holes (staggered 4 inches apart). It has cast iron flanges on both ends; these flanges have four lugs cast on so that the cope and core plates can be bolted on; the lugs are also used to hold the pattern in position while being rammed up. There is considerable machine work done in the making of this rig. The flask is put in the lathe and turned on both ends, so that everything is central when the cores are put in position. The core plates are also finished on all the bearings and joints.

Great care should be taken in fitting up this rig. If you have too neat a fit you will have trouble in taking the castings from the flask; the core plates will expand after becoming heated, and the flask will remain its original size; and if you have too loose a fit you are liable to have your casting thicker on one side than on the other. The only way to find out just what size to make the core plates is by experience; the larger the tuyere, the more clearance you will want. Fig. 2 is a cross section of the flask with the cores in place on the left-hand side. It also shows the cope on the bottom; and on the right-hand side it shows the pattern in position, rammed up to the cope. In casting the tuyere, the metal is poured in at *r*.

Note.—I will here state that the flask swings on the trunnions C C in a frame (or horse, as we call it), not shown in the sketch. This enables the moulder to ram up his pattern, and then swing his flask over so that he can put the cores in position. The cores are all put in position before he puts on the cope; in doing this he can be sure that he has an even thickness metal.

Fig. 3 shows how the shell core is made. It is built on a cast iron mandrel, finished all over; it also has a collar or shoulder at the bottom, to keep the core plate in its proper place. At the top of the mandrel is a small hole E drilled to receive the pin in the sweep; screwed to the bottom of the sweep is a small segment (made of brass), which swings around the shoulder F. In the core plate (G) there are four holes (*y*) in which the vent pipes are fastened. These vent pipes have ⅛ inch holes drilled 1 inch apart; they also help to hold the core after it is taken from the mandrel.

To make the thickness of metal at the butt, segments (H) are used; these segments are also used for the guide (D) to work on. See shoulder marked "F." The segments are cast in one piece, turned and finished all over, and then sawed into the required number of pieces. Fig. 4 shows the core barrel, used in making the center core. It consists of a core plate (I) with four lugs to be bolted into core plate (G). In this core plate is screwed a piece of 3 inch gas pipe (also drilled with ⅛ inch holes). The inside of this pipe is where the "gate" is placed. It also has two slots at the top large enough to allow the "cross-gate" to go through. The outside of this core is formed by a box the same as shown in the cut.

There are different styles of tuyeres, some of them requiring different shaped core plates, pipes, etc. The tuyere shown in the sketch being the simplest and most easily understood, the writer will not attempt to describe any of the others until some future time.

* * *

LAWYERS, DON'T READ!

A LAWYER in a court room may call a man a liar, scoundrel, villain or a thief, and no one makes a complaint when court adjourns. If a newspaper prints such a reflection on a man's character there's is a libel suit or a dead editor. This is owing to the fact that the people believe what an editor says; what a lawyer says cuts no figure.—*Fourth Estate.*

ECONOMIC STEAM RAISING AND UTILIZATION.

ARTHUR HERSCHMANN.

There have been many premature obituaries devoted to the steam engine and boiler during the last few years. It has been rumored that Edison has succeeded in obtaining 80 per cent. of the energy of coal by transforming its chemical energy into electricity. Coincident with this, another stir was made by the ingenious invention of De Laval, who succeeded in improving so greatly upon the steam turbine, that much has been said about its supplanting the steam engine. It is true that a fairly small steam consumption was obtained, but the life of his speed reducing gear has yet to be proved. We find ourselves waiting until a novel system becomes an established fact (as it is expected of the internal combustion engine), before it is considered worth the while to consider how to get the extreme efficiency with our boiler and engine.

The boiler has long been considered only a secondary factor in the steam plant, and its design and manufacture much neglected. Now opinions have altered. Practical experience has grown and science shown its influence, until the same care is given to the selection of the boiler, in accordance with the coal and feed-water available, and with its particular duty, as has for some time been the case with the engine.

The question is constantly being put by power users: "Which is the best boiler in the market, and which must I buy?" A correct answer to this question depends on the merit of one or another boiler type for the case in view. Generally speaking, we say the best boiler for the place in question, is the one which is cheapest in combined cost of purchase and the current costs of its management per unit of steam. The latter means the costs of fuel burned, the boiler attendance, the rent for boiler house and floor space required, and also the allowance for deterioration.

It is well known that the initial expenditure and the current expenses should be in inverse proportion to each other.

The efficiency of the boiler plant is the product of the percentages of efficiency of its furnace and boiler shell. Great waste of coal has often been caused by unduly taxing the furnace. In most cases we find the grate area too small rather than too large for the boiler.

The exigencies of trade force upon steam users the alternative of overloading their existing plant, or incurring the expense of a larger one, and the first method usually seems the cheaper. We often find one chimney which was planned for one boiler doing duty for five and even more, with a poor draft as the probable consequence, as well as the development of the dreaded black smoke, indicating an imperfect combustion.

I may say in passing that a great many people still believe that black smoke represents unburnt fuel in the air, but experiments prove this quantity to be actually not more than ⅓ per cent. Neither is this solid carbon as detrimental to health as the invisible gaseous products of such combustion. In cases of overloaded chimneys, forced draft will do good service in increasing the economy But even well proportioned grates and flues will give different results (the same coal being used) with different firing methods.

Mechanical firing is in general use in America more than in England, and here more than in most parts of the Continent. There is, however, no better way to raise the economy of a furnace than to employ a good boiler attendant; and yet he is often considered one of the last staff members—a helper to the engine tender. In fact, I know of several firms abroad, where the stokers are under control of a clerk of the works. He registers the coal consumed and the evaporation obtained. In order to induce the stokers to give thought to the matter, they receive premiums in accordance with the results obtained, and this system is much more profitable than the increasing number of its followers imagined before they tried it. Such a system will soon betray the origin of any defect.

The second part of the boiler is its shell proper. The tendency to increase the efficiency of the boiler caused the introduction of the high pressure common with modern practice, and improvements intended to produce dry steam. Both these considerations are against a cheap boiler. The higher the pressure, the thicker the shell, the better the material used, and the more costly the workmanship.

Dry steam also means large heating surface and ample water surface, so that the bubbles of steam may rise quickly from the hottest part of the shell and pass through little depth but a large area of water. Good circulation, therefore, is of great importance. The quicker the water passes the shell, the more efficient the heat transmitting capacity of the latter. This efficiency of the shell increases with the increase of difference of temperature on its inside and outside, and this speaks in favor of long boilers, where this can easily be maintained. The difference in the specific gravity of the boiler water is the main cause of its circulation, and artificial improvements have not been very successful.

There has been little advance made upon the rate of evaporation as obtained with some out-of-date boiler types. In fact, these so-called "elephant" boilers, of free water circulation, which preceded the internally fired systems, are for this reason still used in great numbers on the Continent. Their efficiency often exceeds 70 per cent. without the use of an economizer, which is replaced in effect, by several thin-shelled heaters (mud drums) underneath the main boiler. These are in the last flue and form scale preventers for the real boiler.

This system had many drawbacks. The great length of the boiler and consequently its unequal temperature at the front and back unduly strains the shell. The part where the cold feed-water enters, condenses the vapors carried by the combustion gases, which prove very dangerous indeed where the coal used contained much sulphur, as in this case sulphuric acid is deposited on the outside of the heaters, causing rapid corrosion of parts which are difficult of access. Thus the main advantage, *i. e.*, the great difference of the specific gravity of the water, not only causes good circulation and efficient heat transmission, but also these disadvantages. The necessary heating of the extended brickwork with such boilers often means waste (especially if intermittently worked), and this was one of the reasons that led to the general adoption of the internally fired boiler.

We see the attempt to increase the water circulation carried on in the internally fired boiler. The so-called circulation boiler in which the single flue has been brought out of the axis of the main shell, gives better results than the Cornish boiler. The circulation in the Lancashire boiler is also increased, owing, as it were, to the heavier mass of cold water pushing the hotter water between the flues and the outer shell.

The action described above is multiplied in the well known Field boiler, a vertical boiler, the crown-plate of which carries several tubes, which, with their closed ends, project into the fire-box. The water in these tubes rises quickly, heated by the surrounding gases, while open-ended smaller tubes placed inside them, communicate with the colder water on the top of the boiler, which falls down through them, causing rapid circulation and great capacity of steam raising.

As a matter of course, such boilers will raise wetter steam than horizontal boilers, as all the generated bubbles of steam are forced through a small water area. The percentage of water carried over by the steam of such a boiler will be 6 or 7 per cent., while about 1½ per cent. is made in a Lancashire boiler, both "hard fired."

A practical test for wet or dry steam can be made by turning a jet into the air. Superheated and dry steam will flow quite transparently; wet steam will be streaky, and this will show more and nearer to the nozzle the greater its per cent. of water, as a consequence of the different speed of the water and steam composing it. The disadvantages of wet steam, as raised in such a forced boiler, are not to be over-estimated, and they increase before the steam reaches the engine cylinder, according to the length of your piping, locality and steam pressure, independent

of the speed of the steam passing through. There will always be a condensation of a small percentage of water in the pipes, which must be suitably drained, or pipes and cylinders are endangered. The water condensed in valve-chests and ports, however, will rush with the steam into the cylinders and there it spreads over the surface adhering to it as a fine film.

The well known experiments of Prof. Hirn, in Alsace, demonstrated that this film is the reason of great thermal losses during expansion, when the pressure falls and heat is transformed into its mechanical equivalent. The consequence is that the walls of the cylinders lose their heat readily, as the specific heat of their film is greater than that of surrounding dry steam. This heat of the wall is uselessly expended in single cylinder engines in simply evaporating this film and superheating wet steam previous to its exit.

At the beginning of the next stroke the fresh steam meets cold cylinder walls and readily supplies more heat for raising their temperature again, the film and re-evaporation continuing. Thus much more steam is wanted per stroke than the cylinder volume up to the point of cut-off represents. Short stroke, quick running engines with large cut-off, are economical from this point of view.

Some of the many different expedients that have been resorted to with the object of reducing this loss are: Short steam ports, the smallest possible exposed surfaces, jacketing the cylinders to maintain an equal temperature of the walls, and even high polishing of piston and inside of cylinder lids. This polishing is done with the object of getting the smallest actual surface for the given area, but as it removes the skin of the casting to the strength of which much value is attached, besides being costly compared with its advantage, it is seldom done.

Proper jacketing should first of all comprise both cylinder heads, and the jacket should be swept by hotter steam than the admission steam of the engine, as at the beginning of the stroke condensation is greatest. This is often neglected, as the heads are hard to couple up and to drain. This is the reason that the use of a jacket often does not improve the cylinder. This is more especially true when the jacket begins to leak, its condensed water not being drained, and when the liner unduly increases the internal surface exposed for condensation in the cylinder.

No doubt the best remedy is to superheat the steam previous to its being admitted to the cylinder. Saturated steam is steam where the presence of water is evident. If we impart more heat, this water will evaporate; if we take heat away from it (as by heating a shop), this heat previously imparted to transform a certain quantity of water into a certain quantity of steam, is removed and therefore the equivalent of the steam is re-condensed.

If we raise the pressure from say 100 pounds to 200 pounds, we cannot help raising its temperature from 338° Fahr. to 388° Fahr. If we raise the temperature of the water and therefore that of the saturated steam in the boiler, while the piston is moving and therefore at constant volume, we necessarily raise the pressure. *But if the pressure* (and therefore temperature) *is constant, we cannot raise the volume* by imparting more heat.

Such is not the case with superheated steam, and there lies a great advantage of it, *i. e.*, that of its *increase of volume.* There seems to be some difficulty in understanding this property and advantage of superheated steam. Let us consider an instance in figures.*

We superheat steam of say 160 pounds pressure, this being a common one. Now, the properties of the superheated steam are similar to those of gases—its specific volume will increase if we raise the temperature, the pressure being constant. According to "Thermodynamics" we find the steam consumption per unit of work done in the engine to be in inverse proportion to the specific volume of the steam used; this we must bear in mind.

The increase in volume, therefore, is a main feature of superheated steam, together with lessened condensation. How now does the effect of this increase compare with the cost of its generation.

One pound of saturated steam at 160 pounds pressure, 364° Fahr., has a volume of 2.8 cubic feet; at the same pressure superheated to 660° Fahr., it has a volume of about 4 cubic feet. The increase therefore is $\frac{4-2.8}{2.8}$ = over 40 per cent. in volume. To attain this, we had to impart heat to the superheater to raise the temperature of the steam 300° Fahr.

At constant pressure the specific heat of saturated steam is 0.4805 B. Th. U. Therefore for superheating we want $(660-364) \times 0.4805 = 142$ units. To produce one pound of saturated steam, as above from water of 32° Fahr., we want 1224.5 units. Consequently the additional heat we wanted was only $\frac{142}{1224.5}$ or about 11 per cent as against 40 per cent. of increase in volume.

Considering this advantage and the small condensation of such steam in the engine, we can soon estimate the great advantage obtained by superheating steam. In fact there are instances reported where over half the quantity of fuel was saved by a very high degree of superheating.

The advantages of superheating were known some forty years ago, but the method became obsolete, owing to practical difficulties. Animal or vegetable oil, unsuitable packing material, as hemp, rubber, cotton, etc., and the diffusion of steam through the then used cast iron vessels, which begins at 570° Fahr. in our case, prevented its application. It is only a couple of years since a civil engineer in Germany really reintroduced the use of superheated steam in a most ingenious manner. He took advantage of the rapid circulation of the boiler water (as we particularly noted in the Field boiler), and efficiently dried the raised steam by subsequently superheating it. His boiler was very small the grate area, however, was one-tenth of the heating surface.

Wet steam at a speed of 3 000 feet per minute (against 40 feet per minute in a Lancashire boiler) passes from the boiler through the superheated spirals, which are a superstructure of the boiler, swept by the combustion gases. Thus the quicker the combustion the greater the speed of the raised steam and its humidity, which therefore has a greater cooling effect on the spirals of the flue. Tests showed the steam consumption per hour per brake horse-power to be only 11 pounds in a 60 HP. compound condensing engine of his design. This result has been obtained with single-acting cylinders, and the total efficiency of only a medium sized plant came up to 78½ per cent.

Comparing this with the efficiency of saturated steam, raised in an 8 x 30 foot boiler of about 450 HP., which boiler would, with an economizer in use, not exceed 78½ per cent., one cannot help thinking of the advantage in raising steam quickly and superheating it afterwards.

* * *

MR. J. A. JOHNSTON, president of the Gisholt Machine Co., has favored us with a copy of his report on the possibilities of South American trade. Mr. Johnson was a member of the delegation who visited South America under the direction of the National Association of Manufacturers, and the information contained in this interesting pamphlet should prove of value to those desiring trade in those countries. Copies can be had on application to the Gisholt Machine Co., Madison, Wis.

* * *

RULE FOR ESTIMATING TIME AND WORK.

A rather peculiar, though useful application of rules and formulæ, was recently seen in one of the early catalogs of the Meriden Machine Tool Co., Meriden, Conn., from which we quote:

"Estimates of the time necessary to turn on our Forming Lathes articles made from the average quality of metal used by manufacturers of plumbers' good, valves, door knobs, etc, may be as follows: Multiply the largest diameter in inches, of the piece to be turned by its length; then multiply the result thus obtained by 8, and this will give a very close approximation to the number of seconds necessary to put the piece in the lathe, turn it with single forming tool, and take it out of the lathe; for pieces necessary to be turned with double tool, multiply by 12, (instead of 8).

"Examples: Gauge cock body, largest diameter 1⅛, length 2, single tool, 1⅛ x 2 x 8 = 18 seconds. Door knob, largest diameter 2¼, length 1½, single tool, 2¼ x 1½ x 8 = 30⅜ seconds. Basin cock, largest diameter 2, length 3, double tool, 2 x 3 x 12 = 72 seconds."

"When the metal is very hard, or very soft, of course the time necessary to turn a certain piece will be increased or decreased in proportion."

This does not pretend to be exact, but is near enough to give a fair idea of the time required, and has no doubt been appreciated by those contemplating the purchase of such a machine.

* In the subsequent calculation, pocket-book notes of experimental origin appear which are only approximate.

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MAY, 1897.

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SHOP KINKS.

There is probably no one word that expresses more to the mechanic than "kinks," which embraces almost any device out of the ordinary line that has been used for doing work. These devices are as varied as the work they are made to perform and show the inventiveness or ingenuity of workmen as fully as anything we know of. That they interest mechanics generally is shown by the fact that the papers which contain the most shop kinks are the ones which are most successful.

There are a few men who do not wish to give their "kinks" to the mechanical public, thinking it might in some way help their business rivals; but the majority seem to feel that their kinks are so simple that anyone would have devised them, if in fact, they have not already done so.

Both of these reasons are mistakes, however, and we feel safe in saying that there are few instances where anyone loses by showing the shop kinks he uses, as he is almost sure to receive other ideas in return which more than repay him for any loss he might sustain. It is the interchange of ideas which makes possible nearly all of the advancement in any line, and this is especially true of mechanics; where an idea dropped in giving one's experience has, in many cases, resulted in improved machinery and methods.

We believe the exchange of shop kink ideas will be beneficial to all concerned, and the columns of this paper are always open to devices of this kind which have been used in practical work.

* * *

REDUCING EXPENSES.

The prolonged business depression from which we hope to emerge in the near future, has taught us many valuable lessons and though some of them have been costly and others fatal, those who are able to profit by such experience are in a better position to obtain business and handle it economically than ever before. A recent conversation with the head of a large concern illustrates how such an experience may be turned to account if those in charge are of the right stamp to profit by it.

It became necessary in order to run the works and keep the force together, (and this means more to a well established business than many seem to realize), to take contracts far below the regular rates, and in some instances at or below the actual cost of construction. As no business is run for the pleasure to be obtained but for a profit if possible, it became necessary to see whether the cost of construction could not be reduced so as to at least make both ends meet.

Fortunately, both for the men employed, as well as the company, the manager was a broad-minded man, who did not believe that the only way to reduce expenses was to cut wages, and he immediately conferred with the heads of the various departments as to the possibility of getting out more work with the same force, of effecting economies in the use of material, and, in short, of saving in every possible manner. As a result of this, many little leaks were discovered and remedied—leaks which had before seemed insignificant, and which in busy times had been overlooked. Every department was put on its mettle and each one responded by reducing expenses several per cent., for—when the men are treated as men and not as machines—they are nearly always loyal to their employer, and when a man sees that the manager intends using every possible means to avoid cutting his wages, he is bound to do all in his power to aid in keeping his pay at the old rate.

In the case mentioned the expenses were so reduced that a profit was realized on prices which were actually lower than the former cost of construction, and this with the wages no lower than before. When business improves and prices are higher, this firm will be in a position to make a handsome profit, when some of the ones which have been shut down are barely existing.

There are several points to be noted in this case which should be carefully considered by every employer, not alone from the humanitarian standpoint, but as a plain business proposition.

RECENT CHANGES IN THE PATENT LAWS.

GEORGE P. WHITTLESEY.

During the closing hours of the last session of Congress, a bill was passed amending the patent statutes in several particulars. The change most important to domestic inventors is the abolishing of the law by which a United States patent was limited to expire simultaneously with a short-term foreign patent granted prior to the date of the United States patent. Heretofore, if an inventor obtained an English patent before his United States patent was issued, the United States patent would expire with the English patent, that is, 14 years from the date of the English application. Under the new law the United States patent runs 17 years, irrespective of prior foreign patents.

But by another section of this act of March 3, 1897, it is provided that if the foreign patent is granted upon an application filed more than seven months earlier than the domestic application, then no patent at all will be granted in this country. This means that if an Englishman, for instance, files an application in England, he must file his application in the United States within seven months afterwards, or his United States patent, if granted, will be invalid if his English application results in a patent.

This section is evidently intended to make our practice conform to the provisions of Article IV of the International Union for the Protection of Industrial Property, under which a citizen of any country in the Union who has filed his application at home is given seven months within which to file an application in "countries beyond the seas." It is not within the scope of this article to point out in what respect this change in our law fails to conform to this Article of the Union, and is in reality, a discrimination against foreign applicants and especially against the poor foreign inventor.

Another important change in our new law is, that if a description of an invention is published more than two years before the application for a patent is filed, the patent will not be granted, or if granted, will not be valid. In other words, a publication two years old is just as complete a bar to the grant of a patent as a two years public use of the invention. I do not think that this will seriously diminish the number of United States patents, however. Inventors who have valuable improvements nearly always wish to obtain foreign patents. Now, publication in a foreign country before applying for a patent prevents the grant of a patent, or voids it if issued. Hence those who intend to obtain foreign patents are careful to see that no description of their inventions is published, either in this country or abroad, before they have filed their foreign applications. A description in some prior patent, if two years old, is a complete bar, under this section of the law.

Another change of less importance is the one which cuts down, from two years to one year, the time in which an application can be complete and prepared for examination after it has been filed. By the same section, only one year is given, instead of two, as formerly, within which to reply to any action of the Office upon an application. Commissioner of Patents Seymour made a rule about a year ago that Office actions on applications must be replied to in six months. It was attempted to enact this rule into law in this act of March 3d, but Congress thought the time too short, and made it one year.

Another minor provision of this act is, that if an assignment of a patent is acknowledged before a notarial officer, his certificate shall be *prima facie* evidence of the execution of the assignment.

Another section provides that in a suit for infringement, no damages or profits can be collected for infringements committed more than six years before the entering of the suit.

Section 7 is of no especial importance to the general public.

This act goes into effect January 1, 1898.

Another act of March 3, 1897 provides that service of process, summons or subpœna may be made upon the agent of any person, partnership, or corporation conducting business at a regularly established place in the judicial district in which the suit is brought.

By a proclamation of the President, dated March 9, 1897, in pursuance of a convention between Secretary Olney and the Japanese Minister, concluded January 13, 1897, citizens of the United States have now the same rights as Japanese citizens under the Japanese law of patents, trademarks, and designs. Heretofore, Japan has refused to grant patents to foreigners, and American manufacturers have had to submit to seeing their goods imitated by the Japanese at rates defying competition.

ALLOWANCE FOR FORCING FITS.

The question of forced fits is one of considerable importance in many shops, particularly those building engines and large machinery. There is usually very little data obtainable on this subject, as in fact little in the way of uniform practice exists in any of our large shops, each using such methods and allowances as have been found to answer for their particular work. There are so many different factors to be considered that it is probably impossible to make any hard and fast rule for the proper allowances, and all that we can hope to do in this article is to give enough data (which has been collected from some of the leading builders of this country) to show the prevailing practice. This should give those who are not familiar with this kind of work, a starting point to work from, and even though it be nothing very definite as applied to their particular case, it will at least be of service to *guess* from, and seriously, this is about all that can be expected of any data of this kind.

The varying conditions, such as the diameter of hole, length of of hole, smoothness of hole and pin, roundness of hole and pin, whether hole or pin is taper, or both; material of pin or hole and its condition, amount of metal around the hole, pressure available or safe, etc., are among the points to be considered, so that it can be readily seen there are apt to be as many unknown quantities as are known, making a formula to fit all cases, practically out of the question.

The Lane & Bodley Co., of Cincinnati, O., kindly loaned their book containing the recorded data of nearly 500 forced fits made by them between April, 1894, and February, 1897. These record about twenty-five entries for each case, and give the diameter of both pin and hole at six different points, showing the taper, if any, as well as the deviation from roundness. Both the volume of the fitted pin as well as the area of fitted surface was also given, as well as the pressure required to enter the pin, at mid-position and maximum pressure. A few extracts from these will be given later.

Much depends upon the men doing the work, as it can be readily seen that a hole which is bored roughly, or a pin in a similar condition, will not have a bearing its full length, and with the same allowance for forcing, will press easier and consequently not hold as firmly. As an exaggerated case of this, take a threaded nut, with the customary forcing allowance between pin and smallest diameter of hole, and it can readily be imagined that the fit in this case would not be of much account. Then, too, with very soft, spongy iron around the hole, the metal will yield more and a greater allowance is necessary for the same forcing pressure. In the case of locomotive driving-wheels, or steel-tired truck-wheels, the allowance given is in nearly all cases *before* the tire has been shrunk on, proving that cast iron is at best a spongy mass, which yields quite readily under pressure. By considering all these variable quantities, we are in a position to examine the data that has been collected and to gain as much information from it as can be obtained from such a source.

The table following shows the results obtained by Lane & Bodley, and should form a guide for other work. These were obtained with mild steel pins and shafts, pressed into cast iron hubs, with the exception of No. 11, which was a cast steel crank, the pressure required being about double the preceding case, with nearly the same allowance per inch. It will be seen the general rule of .001 of an inch per inch of diameter is considerably smaller than any allowance found in the cases shown, excepting No. 3; but as this was forced with a maximum pressure of one ton, it is not a reliable guide, and was only given to show the result of too small allowance. It will also be noticed that there is little semblance to uniformity in the pressure required for the same allowance, much of this discrepancy being doubtless due to difference in metal of crank disc, more than in pin or shaft.

One correspondent told of making two 7 inch fits, as nearly alike as possible, only to find that one required 41 tons, the other 87 tons; quite a variation, to say the least. All agree that no fixed rule will give exact results.

Mr. Edwin Reynolds informs us that it has been the practice of the E. P. Allis Co. to keep a record of forced fits, presumably similar to that of Lane & Bodley, and that for a diameter of 8 inches their allowance would be .001 of an inch per inch of diameter. For smaller sizes this increases slightly, and decreases for larger sizes. Pressure required varies from 10 to 16 tons per inch for sizes varying from 4 to 30 inches in diameter.

Supt. J. D. Campbell, of Dickson Locomotive Works, advises

us that with a straight hole it is their practice to make the pin taper by the amount allowed for the fit, as when straight the first inch of the hole must stand the pressure and abrasion of the remainder of the pin.

As a general thing the locomotive builders seem to make a greater allowance than stationary engine builders. As they frequently have to fit new pins into old holes, the practice of the Rogers Locomotive Co., on this subject, is worth noting down for reference. They say: "At a second pressing in, the difference allowed must be a little less, as the metal around the hole is made more dense in the first pressing, and will not 'give' quite as much as at the first pressing."

This class of work (locomotive) usually allows from 7 to 12 tons per inch of diameter, probably because of the severe vibrations and shocks sustained in service, and this also accounts for larger allowance made in nearly all railroad work.

One of the nearest approaches to the elimination of the personal factor in forced fits, which are in many cases entirely dependent on a machinist's sense of touch with a pair of spring calipers, can probably be found at the Juniata shops of the P.R.R., and which was, we believe, introduced by Mr. H.D. Gordon when master mechanic there. After extended experiments, a set of gauges were made for each size, the pins turned and the holes bored in different parts of the shop and pressed together as needed. Of course the pressure varies, as the metal is probably slightly different in each case, but an average of 10 tons per inch is adhered to as closely as possible.

been sufficient, so as to require but half the pressure. Yet the allowance is only .0017 per inch as against double this amount in railroad practice.

Professor Sweet writes: "I append a list of the allowance our men make for cranks and shafts, which are of soft steel smoothly turned, forced into strong, easily worked cast iron. The amount of iron outside the hole being in the smallest place, as much as one half the diameter of the pin, and strongly reinforced a good part of the way around. If the casting is perceptably harder than the usual run, a quarter of a thousandth less is allowed. The length of fit is always as much and in some cases more, than the diameter.

"The cranks, which we always force in first, are as follows:

$3\frac{1}{4} - .007$; $3\frac{15}{16} - .0075$; $4\frac{15}{16} - .008$; $5\frac{15}{16} - .009$.

"Shafts:

$3 - .006$; $3\frac{7}{16} - .007$; $4\frac{3}{8} - .0075$; $4\frac{3}{4} - .008$,

all in inches.

"In the case of two 10 inch shafts, we found .01 all sufficient. The formula of .001 per inch of diameter seems to us to be much too little for small shafts. As we use no keys and the wheels do not get loose, we conclude these allowances are satisfactory."

It will be noticed that in most cases the allowance *per inch* decreases slightly as the diameter increases; but in all cases so far noted the *total* allowance is larger than in small diameters. The one exception to this is the table furnished us by Mr Chas. O. Heggem, superintendent of Russell & Co., Massilon, O., as

TABLE NO. 1.—EXTRACT FROM LANE & BODLEY CO.'S RECORD BOOK OF FORCED FITS.

No.	Mean Diameter of pin, inches.	Length of fit, inches.	Mean Diameter of hole, inches.	Total Allowance.	Allowance per inch.	Area of Fitted Surface, square inches.	Volume of Fitted Surface, cubic inches.	Pressure to enter pin, tons.	Pressure at Mid-position, tons.	Maximum Pressure, tons.
1	1.8798	6.125	1.8767	.0031	.0017	36	16.7	2	10	20
2	1.8819	6.125	1.877	.0042	.0022	36	16.7	2	15	23
3	1.8774	4.375	1.8764	.001	.00052	24.4	13.7	½	1	1
4	2.7455	4.5	2.7387	.0068	.00247	38.7	26.5	3	12	25
5	2.7465	4.5	2.7437	.0028	.001	38.7	26.5	5	12	23
6	3.261	5	3.2542	.0068	.0021	51	41.5	5	20	45
7	3.2625	5	3.2555	.007	.002	51	41.5	5	15	30
8	3.267	5	3.261	.006	.0018	51	41.5	5	15	20
9	4.2505	6	4.2402	.0103	.0024	79.8	85.1	5	22	44
10	4.2388	6.625	4.2478	.0091	.0021	78.1	93.4	12	30	60
*11	4.2303	6.5	4.2224	.0079	.0019	95.8	91.	10	60	125*
12	5.9343	4.0625	5.9216	.0127	.0022	75.7	112.2	6	16	25
13	5.9381	4.	5.9252	.0129	.0022	74.4	110.4	3	18	35
14	5.9294	4.125	5.9194	.01	.0017	76.7	113.8	5	15	25
15	6.8829	5.125	6.8697	.0132	.002	110.7	190.1	8	20	42
16	6.889	5.	6.8785	.0105	.0015	108.	18 .9	5	22	45
17	6.8692	4.875	6.855	.0142	.0021	104.8	180.4	5	35	65
18	7.8884	5.5	7.873	.0154	.002	135.9	267.3	5	32	64
19	7.8715	6.5	7.8575	.014	.0018	160.5	315.9	5	25	50
20	7.862	5.625	7.846	.016	.002	138.2	272.8	8	40	80
21	8.924	6.125	8.905	.019	.0021	170.8	378.9	20	45	68
22	8.9	6.75	8.8848	.0152	.0017	188.4	419.9	5	47	96
23	8.878	6.5	8.8669	.0112	.0013	180.7	401.	10	45	92

* No. 11 was a cast steel crank disc.

The allowance here averages about .0035 of an inch per inch of diameter, considerably more than in most cases of stationary practice we have found.

As a proof of this, three instances are cited.

First: 80 pins, 5⅜ inches in diameter; allowance, .017; lowest pressure, 35 tons; highest, 80 tons; average for the lot, 56 tons.

Second: 20 pins, 6 inches in diameter; allowance, .023 inch; lowest pressure, 55 tons; highest, 90; average for the lot, 71½ tons.

Third: 60 pins, 4 inches in diameter; allowance, .013 inch; lowest pressure, 30 tons; highest, 60 tons; average for the lot, 45 tons.

Mr. G. W. Dickie, manager of the Union Iron Works, San Francisco, Cal., writes that in a general way, they allow .001 of an inch per inch of diameter, but that this must be varied in accordance with conditions of material, etc. He also states that they endeavor to fix the allowance so as to obtain from 200 to 500 pounds pressure per square inch of surface.

With this as a basis it is interesting to see how it compares with some of the data already obtained. Taking No. 1 from the Lane & Bodley table and we have 36 square inches of fitted surface. Multiplying by 200 gives 7 200 pounds, and by 500 we get 18 000, or 3.6 tons and 9 tons as the extremes suggested by Mr. Dickie and substantiated by his experience. This shows that, if these surmises are correct, a smaller allowance would have

representing their practice. They obtain a pressure of 4 tons per inch of diameter and use the allowances that follow:

TABLE NO. 2.

FOR PRESS FITS—CAST IRON CRANKS.

Diameter of hole	...	4	to	5	inches.	Allow	...	.0090 inch.
" " "	...	5	"	7½	"	"	...	.0060 "
" " "	...	7½	"	9	"	"	...	.0055 "
" " "	...	10	"	12	"	"	...	.0050 "
" " "	...	12	"	16	"	"	...	.0040 "
" " "	...	16	"	18	"	"	...	.0030 "

FOR SHRINK FITS—CAST IRON CRANKS.

Diameter of hole	...	4	to	5	inches.	Allow	...	.0045 inch.
" " "	...	5	"	7½	"	"	...	.0030 "
" " "	...	7½	"	9	"	"	...	.0027 "
" " "	...	10	"	12	"	"	...	.0025 "
" " "	...	12	"	16	"	"	...	.0020 "
" " "	...	16	"	18	"	"	...	.0015 "

The last table is also the allowance for both press and shrinking fits with *steel cranks*. Mr. Heggem strongly advises shrinking steel cranks on instead of pressing them, as it has been their experience that, even when well lubricated, there is a great tendency to "seize," which can only be successfully overcome by shrinking.

It will be seen that in this table the *total* allowance for an 18 inch shaft is but one-third the allowance of a 4 inch pin, Mr. Heggem stating that the increased length of bearing in the larger sizes compensates for the reduced allowance and makes

the required fit, which is of course substantiated by the fact that their engines are in successful operation.

The shrinkage allowance for cast iron will be noted as being just *one-half* the forcing allowance for the same sizes, while general practice seems to indicate about 50 per cent. greater allowance for shrinking than for forcing.

Mr. J. H. B. Bryan, now superintendent of the Snow Steam Pump Co., recommends a lubricant of white lead and lard oil mixed to the consistency of paint, which, placed on contact surfaces, will prevent cutting while being pressed on.

We give a brief summary of the prevailing practice, as gathered from the different makers by quite an extensive correspondence, in the belief that it will be of value as a starting point, from which individual requirements can be found and complied with. It is probably impossible to formulate any rigid rule which shall fit all cases, but it certainly seems better to know what others are doing than to "go it blind" until we find something that may answer our needs, but that may require more pressure than necessary, strain the metal more than need be, and be an uneconomical practice.. Any further information will be thankfully received and duly acknowledged.

BRIEF SUMMARY OF GENERAL PRACTICE.

	Diameter, inches.	Total Allowance.	Allowance per inch of Diameter.	Pressure (tons) per inch Diameter.	Remarks.
E. P. Allis Co., Milwaukee, Wis.	8	.008	.001	10 to 16	Allowance is more on smaller sizes, less on larger.
Baldwin Locomotive Works, Philadelphia, Pa.	5 to 9	.015 to .027	.003	10 to 15	Axles.
	3 to 6	.0045 to .009	.0015	5 to 10	Wrist pins.
H. Bollinckx, Brussels, Belgium.	2.2	.0039	.0018	9	Crank pins.
	1.18	.0027	.0023	2 to 3	Lever pins.
	11.4	.0098	.0008	1 to 2	Cylinder cases.
	1.49	.0059	.004	12	Piston rods into piston.
Buckeye Engine Co., Salem, O.	3 to 10	.01 to .015	.003 to .0015	9 to 10	
Buffalo Forge Co., Buffalo, N. Y.	4 to 10	.01 to .03125	.0025 to .003		
	15 to 40	.047 to .0625	.003 to .0015		
Dickson Mfg. Co., Scranton, Pa.	4.5	.01	.0022	8	Diameter over 5 inches, 7 tons.
Juniata Shops, P. RR., Altoona Pa.	5.375	.017	.0031	10	With 80 pins, pressure varied from 35 to 80 tons; average, 56.
	6.	.023	.0038	10	With 20 pins, pressure varied from 55 to 90 tons; average, 71.5
	4.	.013	.0032	10	With 60 pins, pressure varied from 30 to 60 tons, average, 45
Lane & Bodley Co., Cincinnati, O.	2.74	.0028 to .0068	.001 to .0025	8.35 to 9.1	
	3.26	.006 to .0068	.0018 to .0021	6.15 to 13.8	
	4.25	.0103	.0024	10.3	
	5.93	.0127	.0022	4.21	See table No. 1 for more details.
	6.88	.0132 to .0142	.002 to .0021	6.12 to 9.5	
	7.88	.0154 to .016	.002 to .0018	8.27 to 10.02	
	8.90	.019 to .0112	.0021 to .0013	10.35 to 7.65	Least allowance takes greater pressure.
Philadelphia Engineering Wks., Philadelphia, Pa.	3 to 6	.002	.0007 to .00035	40 tons Total	
	6 to 9	.004	.0007 to .0005	75 to 80 Total	Same allowance and pressure for sizes on each line.
	9 to 12	.006	.0007 to .0005	100 Total	
	12 to 18	.008	.0007 to .00045	150 Total	
Rogers Locomotive Co., Paterson, N. J.	4 to 9	.015 to .022	.004 to .0024	12	
Russell & Co., Massillon, O.	4 to 7.5	.009 to .006	.0023 to .0012	4	
	10 to 18	.005 to .003	.0005 to .0001	4	See Table No. 2.
Schenectady Locomotive Wks, Schenectady, N. Y.	5 to 8			10 to 11	Axles.
	3 to 6			5 to 8	Crank pins.
Straight Line Engine Co., Syracuse, N. Y.	3.25 to 3.9375	.007 to .0075	.002 to .0019		
	4.9375 to 5.9375	.008 to .009	.0016 to .0015		Both crank pins.
	3. to 3.4375	.006 to .007	.002 to .0022		
	4.375 to 4.75	.0075 to .008	.0017 to .0017		Both shafts.
Union Iron Wks., San Francisco, Cal.	Generally	about	.001	Endeavor to obtain 200 to 500 lbs pressure per sq. inch of contact surface.	

TABLE NO. 3.

FROM DATA FURNISHED BY H. BOLLINCKX, BRUSSELS, BELGIUM.

Diameter.	Length.	Total Allowance.	Allowance per inch.	Total Pressure.
CRANK PINS.				
2.2	2.76	.0039	.0018	43 300
2.79	3.78	.0049	.0018	49 500
3.145	4.32	.0058	.0018	55 500
LEVER PINS.				
.865	1.57	.0023	.0027	6 800
1.1	1.77	.0025	.0023	6 800
1.18	1.965	.0027	.0023	6 800
1.375	2.36	.0031	.0023	9 060
CYLINDER CASES.				
11.4		.0098	.00086	37 100
17.7		.0098	.00055	37 100
PISTONS.				
1.49	4.32	.0059	.004	37 100
1.46	4.32	.0059	.004	49 500
1.77	4.76	.0070	.004	55 500
2.24	11.18	.0039	.0017	61 800
2.63	11.18	.0039	.0015	74 000
2.95	13.12	.0049	.0017	113 200

THE MECCA OF FREAKS.

Perhaps it is the atmosphere of Philadelphia, the Schuylkill water, or a combination of both, which causes that city to be selected by schemers for selling stock, but whatever the cause, it has certainly been infested with more wild schemes than almost any city we know of. Among them are the Keeley motor, which has been going to mote for years—and hasn't, but has provided a good living for Keeley and others; the Pneumatic Railway, which was to run trains at any speed you wished, 200 miles an hour or more, on vacuum; the Shaw locomotive, with its grasshopper cranks and duplex cylinders; the Bates thermic motor, which has fallen far short of its promised performance and has, to all appearances, been abandoned; and the prize freak in railroad lines, the Holman locomotive, is again trying to sell stock there. As most of the readers know, this is another attempt to "gain power." They mount the drivers on auxiliary trucks and imagine they fool the engine into running faster with the same power. When they attempted this a few years ago they refused admission to their exhibition to anyone who had expressed adverse opinions, and to some who hadn't, but who probably looked skeptical.

The dailies are being filled with "stuff" regarding it, and it is asserted that the South Jersey R. R. has ordered two of the engines. When it is considered that this is practically only a summer road (there being little or no traffic in the winter), and that its trains run semi-occasionally—if on time—the importance of adoption by such a line can be readily seen, if you are enthusiastic enough. The latest report is that, despite the surplus of power of the first engines, a larger one is to be built to do the work.

This would be laughable if it were not so serious, for after capital has thrown itself away on such a scheme as this, which any mechanic knows is worse than useless, it is hard to induce it to go into legitimate enterprises. When capital learns that schemes which promise large dividends are generally unreliable, it will do more for honest industry at a fair profit. "Something for nothing" never has worked and it never will.

* * *

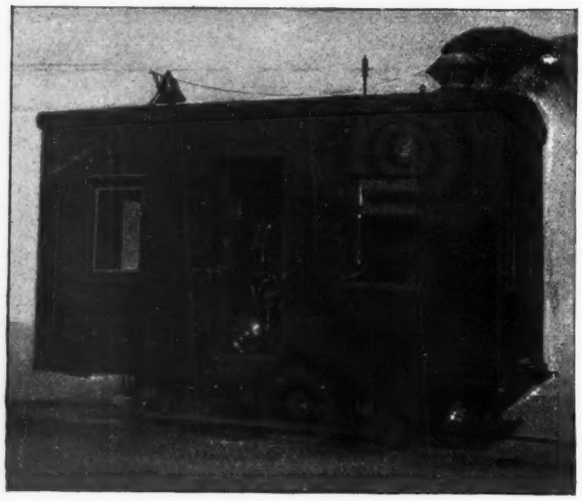
MR. STEPHEN H. ANGELL, consul at Roubaix, France, reports the existence of a large demand for oak in that section, which he thinks could be supplied from this country if proper efforts were made to secure the trade. One firm there informed him that they purchased $400,000 worth of oak per year.

A FREIGHT-SHIFTING MOTOR.

PETER H. BULLOCK.

There are many industrial establishments that have private freight yards where they handle a large number of cars, but which do not have any economical method of moving them from place to place, as may be required in handling the freight at the several shipping and delivery points around the premises. Of course it is well known that there are locomotives built for this special purpose, and that they are very effective and economical where there is sufficient work to justify their employment. To show that it is possible for most any establishment that has such work to do and has an efficient mechanical department, to equip themselves with a motor that will be satisfactory in every way, will be the object of this article.

The institution the writer is connected with handles about ten cars per day, and has nearly a mile of track and sidings distributed in the various parts of the yard, and the cars have to be shifted a good deal in order to properly handle the freight. To produce a cheap and effective motor to do this work was the problem assigned the writer. There is an ample electrical plant on the premises from which current might be taken, but there are objections to the necessary trolley, feed and guard wires that such an installation would require, and besides it is sometimes desirable to go outside our own limits for cars, and where trolley cars would not be tolerated. It therefore seems that a steam driven motor was the only thing that could be used under the circumstances.



A FREIGHT SHIFTING MOTOR.

I do not suppose that all establishments have as many things laying around that could be used in the construction of a railway motor as we did, but all of the material could have been bought and erected for about a thousand dollars. The car or motor is 16 feet 8 inches long with a wheel base of 8 feet, and weigh 27 000 pounds. Common freight car wheels were used, the axles having a space of about 8 inches, turned off true inside next the wheels for fitting gears or sprocket wheels on to. The boxes are set in regular housings and bracket pedestals, and are supported on common spiral springs. The floor in one end of the car is dropped below the sills so as to give extra height for the boiler, which is a 3 by 7 foot upright, set overhanging the forward axle and securely held by diagonal braces to the base and sides of the car. The engine is a 7½ x 8 inch double upright and stands a little forward of the rear axle, but on a floor even with the top of the sills. Water tanks are set each side of the boiler having a capacity for about three hours work. There are two separate transmissions from the crank shaft to the axles; one to the forward one by steel chain sprocket wheel and gear 7 to 1; the other to rear axle by steel chain and sprocket wheel direct, 3 to 1. The motor will move five and two loaded cars respectively, at a rate of about three and seven miles per hour, with a fair speed of engine. By a system of arms and jaw clutches either transmission is thrown into gear by a lever attached to the frame of the engine.

In the rear end of the motor is located a fire-pump that can be attached to any hydrant, or by suction hose to pump from reservoir or lines. Coke has been found to be the best fuel, and the cost of the same is about a dollar a day. One man to run the motor and six laborers can do more work than ten men and four horses, from which it will be seen that it is a decidedly profitable thing to have around.

* * *

THE little article by R. E. Marks, about the adjusting screw for the spring bed, which appeared on page 206 of the March issue, has created considerable laughable comment and several have noted that the point of the screw, as well as the head, was larger than the body, and insinuated that Mr. Marks was not as observing as he should have been, or he would have seen that it couldn't possibly have been screwed through the nut. We have reminded Mr. M. of this, and he replies: "The engraver was evidently in league with the editor to tarnish my mechanical brilliancy, and made the point of screw altogether too large." This evidently clears Mr. Marks' reputation.

* * *

THE *Printer and Bookmaker* issued a special New York number in April which contains fine half-tones of the homes of the daily papers, as well as other interesting views in the city.

* * *

GEAROLOGY—UNIFORM TEETH.

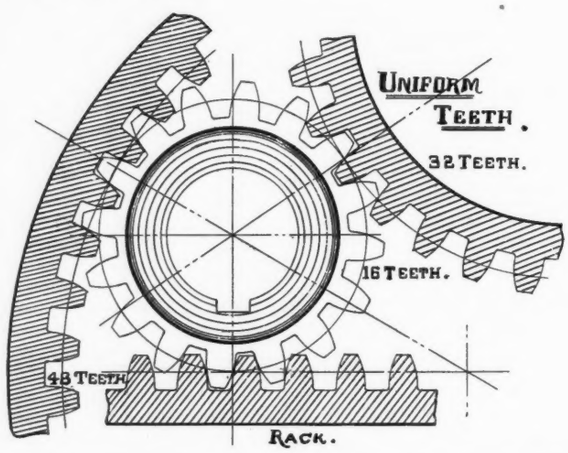
F. W. CLOUGH.

By the term "uniform" it is meant that the teeth are alike in form and size, for the same pitch per inch diameter, on wheels of different diameters. For example, a train of wheels from a rack to 16 teeth inclusive, have the same shaped teeth.

The illustration shows a rack, a 16-tooth wheel, a 32-tooth wheel and a 48-tooth internal gear, all in contact; observe that the teeth are alike on each wheel.

Some of the technists will, no doubt, shake their heads, and put on a wise look of apprehension, but these teeth *go* notwithstanding this, and have given good satisfaction when correctly made.

These uniform teeth wear well in hard service, owing to the fact that they do not come into contact on the approach side of wheels in revolution until the angle of teeth have reached the point where they roll together, even under heavy loads. They will, without doubt, give twice the service in actual use that the best epicycloidal shaped tooth will, and these teeth do not easily wear out of their original form. This is more than can be said of the epicycloidal tooth in heavy service. This tooth is of equal strength on all wheels.



When I say uniform teeth, I do not mean to be understood as advocating that almost any shape of tooth may be cut out of gear blank provided they are all alike. There is a correct form to use in working out the tooth which will run well, and it is just as necessary to know how with this, as with any other form of tooth.

Suppose some of our "tech" friends try it in some leisure hour; it is quite likely the hour would multiply several times before they would get it, unless shown how to lay out the teeth. I could cite cases where the uniform tooth rack and pinions have been used because they ran easier than the involute.

This subject of cog-wheelology is full of interest and covers a large field.

DESIGNING AN ENGINE SHAFT GOVERNOR.—5.

THEO. F. SCHEFFLER, JR.

GOVERNOR WEIGHTS AND SPRINGS.

In connection with governors, table No. 2 has been compiled, giving the diameter of steel used with different size engines, also various other dimensions, such as the distance from center of shaft to center of weight, or the initial position of weight in feet, also the maximum position; the theoretical difference between these two positions; total length of spring with minimum load; safe opening on spring per coil per 100 pounds; the diameter of weight used and the thickness of same; the number of pounds contained in weight approximately; the centrifugal force in pounds at initial position of weight; the centrifugal force in pounds at the outer position of weight; and the number of revolutions per minute. These springs have been used successfully for a number of years on the different size engines, and with a small variation in number of revolutions of engine shaft. The formulas given in this book were used in calculating the springs and weights; in some cases it will be noticed that the theoretical opening of spring is somewhat under the actual opening (the actual opening of spring is calculated when the weight is at its extreme position, and is very seldom at that point), and in some of these cases the springs were changed to suit the conditions. And further, in calculating a spring, it should always be figured a litter stiffer than what is actually needed, for the constant tension on the spring will weaken it to some extent.

Referring to the table the first size given is the 6 x 9 engine governor; the centrifugal force in pounds at C is 193.8, and at B 133.1 pounds, the difference between the two is 60.7 pounds. The pull of valve for this size engine is about 40 pounds at each weight, and deducting the 40 pounds from the 133.1 gives 93.1 pounds initial tension on spring to balance at the inner position of weight; it is better, however, in order to have the governor weights balance with the springs at one-quarter or one-fifth cut-off, to deduct about 28.1 pounds from the 93.1 pounds, this will have the effect of making the theoretical spring opening more equal to the actual opening between B and C, as then the spring tension will not equal the weight centrifugal force at the initial point, and therefore, this 28.1 pounds must be added to the 60.7 pounds difference between B and C. This 28.1 pounds, however, only applies to the 6x9 engine, and the other engine will have to be proportional according to size; the 28.1 pounds is just 46 per cent. of the difference between B and C. The high speed automatic engine governors, at the bottom of the table, are calculated a little differently, as there is a ratio of 1¾ and 2 on the governor weights; the first four engines of 1¾ to 1 and the last four have ratio of 2 to 1; that is, the weight has the pull of the valve directly at the center of the weight, and the spring is attached between the weight fulcrum and the weight proper. Referring to drawing Fig. 23, shows a graphical method of laying out the spring tension and centrifugal force of a governor spring. The line *a b* denotes the maximum spring deflection, it is found by multiplying the total number of active coils by the total load in hundreds of pounds, and this answer by the constant given in the spring table for safe deflection per coil of 100 pounds, which in this case is .0661. The line *a c* is the spring tension in pounds. The scale of diagram is 80 pounds per inch high. The line *c d* repre

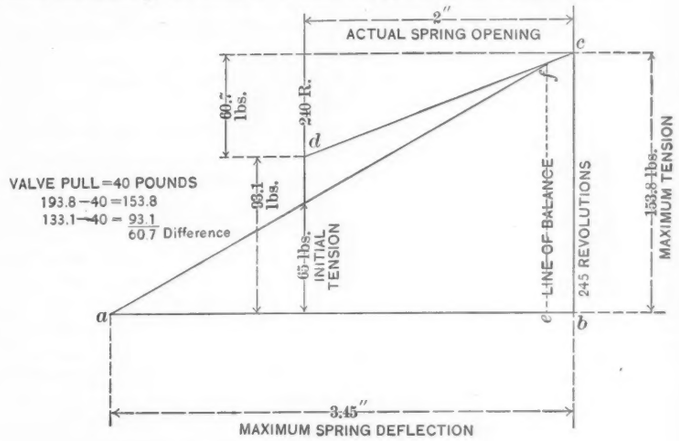


FIG. 23.

Table giving Principal Dimensions of Standard Governors.

See Fig. 24. Table No. 2.

Size of Engine.	Diameter of Weight. in inches.	Thickness of Weight. in inches.	Number of Pounds in Weight and part of Arm.	Number of Revolutions of Engine Shaft per Minute.	Centrifugal Force in Pounds at C.'	Centrifugal Force in Pounds at B.'	Number of Pounds difference between B & C.	Opening of Spring between B & C. in inches.	Theoretical Opening of Spring between B & C.	Total length of Spring with Minimum Load on Spring. in inches.	Safe opening of Spring per Coil per 100 pounds.	Diameter of Spring Steel. in inches.	B in feet.	C in feet.
6 x 9	3.5	3.5	10	240	193.8	133.1	60.7	2	1.348	13.95	.0661	5/16	.68	.95
7 x 10	3.5	3.5	10	240	193.8	133.1	60.7	2	1.348	13.95	.0661	5/16	.68	.95
8 x 10	3.25	3	12	210	205.4	161.8	43.36	2	1.382	18.87	.0889	3/8	.90	1.09
8 x 12	4	3	14	210	239.6	178.8	60.82	2	1.728	17.19	.0889	3/8	.90	1.09
9 x 12	4	3	14	200	217.8	171.3	46.48	2¼	1.414	18.92	.0889	3/8	.90	1.09
10 x 12	4.5	3.5	18	200	336.6	254.5	82.1	2½	2.187	18.00	.0889	3/8	1.04	1.31
10 x 15	4.5	3.5	18	200	336.6	254.5	82.1	2½	2.187	18.00	.0889	3/8	1.04	1.31
11 x 15	4.5	3.5	18	200	336.6	254.5	82.1	2½	2.187	18.00	.0889	3/8	1.04	1.31
12 x 16	4.5	3.5	20	200	468.2	361.7	106.4	3¼	2.323	23.34	.0548	7/16	1.33	1.64
13 x 16	4.5	3.5	20	200	468.2	361.7	106.4	3¼	2.323	23.34	.0548	7/16	1.33	1.64
14 x 16	5	3.75	23	200	522.1	403.4	119.7	4	2.620	24.05	.0548	7/16	1.29	1.59
14 x 18	5	4	26	180	480.7	369.2	111.5	4	2.444	23.38	.0548	7/16	1.29	1.59
16 x 18	5	4.5	28	180	602.2	470.3	131.96	4	2.888	25.17	.0548	7/16	1.46	1.85
18 x 22	6	4.75	45	160	849.1	634.5	214.6	4¼	2540	27.52	.0297	1/2	1.62	2.04
20 x 24	8	6	90	150	1585.8	1204.2	381.6	4¼	2.651	30.92	.0174	9/16	1.75	2.16
8 & 9 x 10 High Speed	3.25	2.5	10	300	423.7	394.7	29	1 3/16	1.096	30.4	.0548	7/16	1.29	1.34
10 & 11 x 12 H. S.	4	2.5	14	300	708.2	651.0	57.2	1 7/16	1.180	32.8	.0297	1/2	1.52	1.60
12 & 13 x 12 H. S.	4	2.5	17	275	656.8	615.2	41.6	1 7/16	.908	35.2	.0297	1/2	1.41	1.45
14 & 15 x 14 H. S.	4.5	3.75	20	275	975.2	867.6	108.6	1 9/16	1.508	34.36	.0174	9/16	1.69	1.83

sents the centrifugal force minus the valve-pull; the line *ef* shows at what part of the spring deflection the spring tension balances with the centrifugal force.

For illustration of governor pulley showing position of weight and spring approximately and reference letters, see Fig. 24.

GOVERNOR FORMULAS APPLYING TO GOVERNORS WITH MOVABLE ECCENTRICS ONLY.

Notation as follows:

A = distance from center of weight fulcrum to center of spring, in inches.

B = distance from center of weight fulcrum to center of eccentric link connection on weight, in inches.

C = distance from center of weight fulcrum to center of gravity of weight, in inches.

D = distance from center of eccentric case fulcrum to center of eccentric, in inches

E = length of lever operating eccentric, in inches.

F = valve pull at center of eccentric, in pounds.

G = valve pull at weight, in pounds.

H′ = spring tension in pounds for maximum load.

I = centrifugal force required at center of gravity to balance spring tension, in pounds.

J = centrifugal force required to balance valve pull at center of gravity of weight, in pounds.

K — Total number of pounds centrifugal force required at center of gravity of weight to balance spring tension and valve pull, in pounds.

$$\text{Then } G = \frac{F \times D}{E} \text{ and } H' = \frac{G \times B}{A} \times 3 \times 1.33$$

$$\text{and } I = \frac{H \times A}{C} \text{ and } J = \frac{G \times B}{C} \text{ and } K = 1 + J.$$

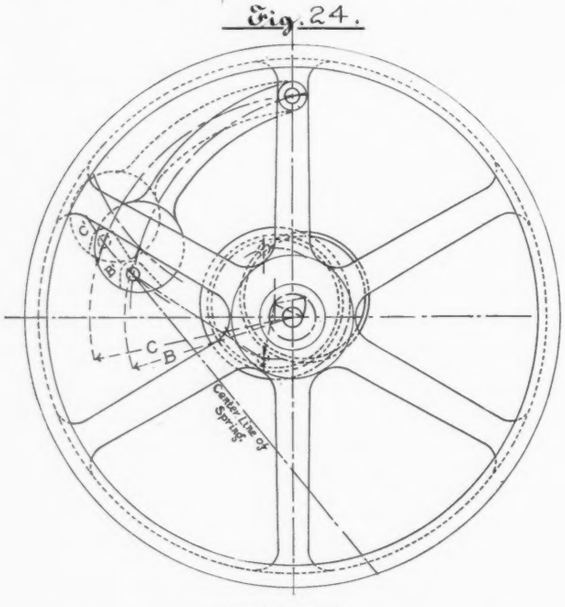
H = spring tension in pounds for minimum load or initial tension.

$$H = \frac{G \times B}{A} \times 3$$

GOVERNOR DESCRIPTION AND INSTRUCTION TO CHANGE THE SPEED.*

Referring to assembled drawings Figs. 25 and 26, the connecting-rods between weights and eccentric, are made of refined wrought iron. The spring tension, or adjusting screws and eye-bolts and all pins, are made of machinery steel, and of sufficient diameter to sustain the maximum load at any time. The weights

Fig. 24.



GOVERNOR PULLEY.

are of cast-iron, and so arranged that a difference in speed may be obtained by adding or removing some of the weight in the weight-arm. A difference in speed not exceeding 15 revolutions may be made with the accompanying springs, but for a greater difference, not exceeding 50 revolutions, new springs or weights, and probably both, will be required. The mechanical suspension

* These instructions are sent to customers.

of the weights, springs and eccentric, is such that all are in one center line, with no overhang whatever, except that of the eccentric proper, which of course, is necessary on account of the eccentric-rod clearing the pulley. The wearing parts of the eccentric case are adjustable. The wear on the circumference of the eccentric can be taken up by removing one of the liners be-

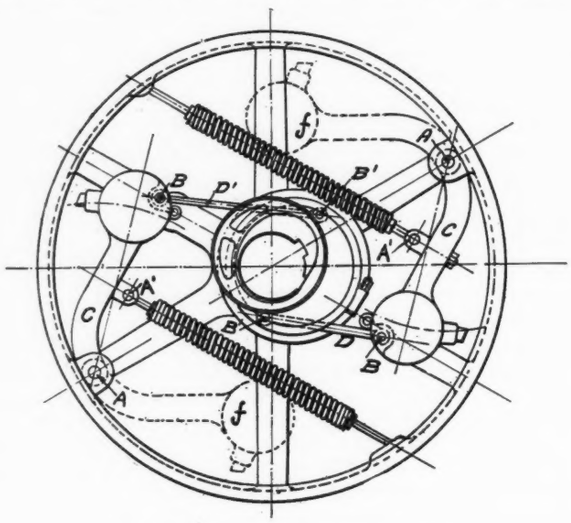


FIG. 25.—GOVERNOR FOR FOUR VALVE ENGINE.

tween the two halves of the eccentric case and by screwing up the nuts on the studs. The side wear can be taken up by adjusting the six bolts that secure the eccentric case to the pulley flange. When wear has taken place to any great amount, the flange on the eccentric case should be filed and scraped until it takes up all the wear.

The eccentric is suspended so that the lead changes with the load, the more load the more lead, and the less load the less lead, is required. In order to obtain the above the eccentric is made to swing across the shaft. If necessary, the governor can be reversed, that is, the wheel can be made to run over or under as may be desired, both for right-hand and left-hand engines, as the case may be, without obtaining a new governor. All parts are interchangeable and can be renewed at any time. All wearing surfaces are provided with oil or grease cups.

DIRECTIONS FOR REVERSING THE GOVERNOR.

1. Obtain the correct length of the spring when the springs are at their initial tension, when weights are nearest the center of shaft.

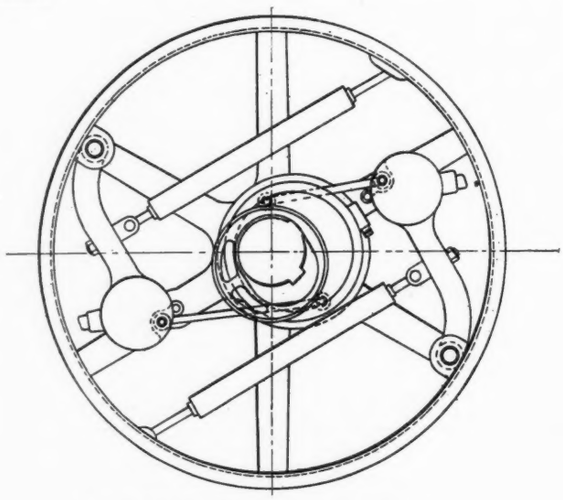


FIG. 26.—LEFT HAND GOVERNOR, FOUR VALVE ENGINE.

2. Remove pins A, A′, B and B′ and weight-arm C, also connecting links D, and D′.

3. Change position of weight-arm C to position at *f* as indicated by dotted lines of weight-arm. Also, turn eccentric and eccentric-case to a reverse position as shown by left-hand governor. When the weights are reversed, the eccentric and case turned, the connecting links D and D′ change places, that is the

short link. D takes the place of the long link D', but in the weights only.

4. Put links in place and connect up again by means of pins A, B and B'.

5. Replace springs and turn the adjusting screw until the springs are the same length they were before removing them.

6. Remove key from pulley hub, and turn pulley on shaft until the other keyway is opposite the keyway in the shaft and then drive in key. Then see that all the bolts are secure and will not work loose. The valves may want a little re-adjusting, from the changes having been made; if so, they should be adjusted by the indicator, in order to have both ends just alike. Further, the speed may not be just correct, as everything was done by measurement, and a quarter or one-half turn of the adjusting screw on springs may remedy the speed, either one way or the other, or by a little difference in the governor weights.

* * *

BABBITT METALS.

C. VICKERS.

"Genuine" babbitt is composed of a small quantity of copper, added to tin and antimony. No lead is used, for the adjective "genuine" is applied especially to distinguish it from the cheaper grades containing lead.

There is considerable temptation to adulterate it with lead, owing to the difference in value of lead and tin; one pound of lead added to 100 of "genuine" makes a gain of about 18 cents. The character of the alloy would not be greatly altered, but when the purchaser pays for the best he certainly has a right to expect it. Fortunately, it is easy to detect such adulteration; take a piece and use it for a pencil, if it makes a mark, then it contains lead, as a small amount of lead added to tin causes the latter to mark paper. The following proportions may be used in making this alloy:—

No. 1.	Copper	4 lbs.
	Tin	8 "
	Antimony	8 "

This forms the hardening, as it is called. First melt the copper, add the tin and afterwards the antimony; remove from the fire and let cool down to a dull red heat, then add 16 pounds more tin to increase the fusibility of the hardening. This makes 32 pounds hardening, add this to 64 pounds more tin—the proportions of tin to hardening thus being two to one. The additional tin should be melted separately in a kettle or suitable vessel, and the hardening added either in ingot form, or direct from the furnace; in the latter case be sure the tin is all melted, otherwise an accident might occur by the hot metal from the furnace falling on the damp end of a projecting ingot.

To prevent loss by oxidation, the contents of the kettle should not be heated much above the melting point. In cases where a cheaper composition is desirable, the following can be recommended:—

No. 2.	Genuine hardening	32 lbs.
	Tin	64 "
	Lead	93 "

This forms a good alloy; another one is:—

No. 3.	Hardening	16 lbs.
	Tin	50 "
	Antimony	20 "
	Lead	80 "

In mixing this alloy, first melt a portion of the lead, say 40 pounds, in the kettle, or in a crucible in the furnace, bring to a dull red heat, add the antimony, in small pieces, when melted add the balance of lead. Do not attempt to melt the antimony without the lead bath, as it is a volatile metal and there would be loss from oxidation.

In making all alloys containing hardening, a furnace is necessary, on account of the heat required to melt the copper. The following mixtures contain no copper, and are fairly good compositions:—

No. 4.	For hardening, take Lead	145 lbs.
	Tin	40 "
	Antimony	20 "

Melt 145 lbs. lead and 40 lbs. tin and add 52 lbs. hardening.

No. 5.	For hardening Lead	48 lbs.
	Antimony	26 "

add this amount to 152 lbs. lead. The hardening is used in this merely to form a bath for the antimony, and any portion of the 200 lbs. lead may be taken. This is cheap and soft.

Another cheap composition is formed, as follows, and is known as "hard lead":

No. 6.	Lead	80 lbs.
	Antimony	20 "

Hard lead is a better metal than No. 5. It is largely used for lining car journal bearings. It may be improved by the addition of tin as in the following:—

	Hard lead	100 lbs.
	Tin	100 "

This is given as an illustration. A great variety of alloys can be made by taking hard lead as a base and adding tin in varying quantities.

Zinc is sometimes added to cheap alloys. It has a tendency to form unsightly ingots, owing to the formation of bubbles on the surface. It should be kept out of strictly high-class babbit. It has been suggested that the addition of aluminum improves babbitt metals. But, while this may be true, the writer does not consider that the improvement will be sufficient to pay for the increase in cost. Bismuth is also sometimes used, but it possesses no advantage over antimony and is more expensive.

Before pouring into ingots, the dross which forms a scum on the surface of the liquid metal, should be skimmed off and saved. The percentage of dross may be lessened by the use of a flux. Rosin, tallow, or grease of any kind, is a good flux for babbitt alloy. When any considerable amount of dross has accumulated, it may be melted by adding rosin and small quantities of crude salammoniac. The flux must be thoroughly mixed into the pasty mass, until it liquifies, and the dross floats on the surface in the form of a greenish dust, it may then be skimmed off and the metal poured into ingots.

* * *

MATHEMATICS AND STEAM ENGINEERING.

Notwithstanding the persistent efforts of a hundred years, during this time steam engineering has been one of the greatest of undeveloped matters before the world, very little progress has been made in bringing it to a direct and exact science, like the science of mathematics, or to the precise solution of the most common problems in relation to it.

Take compounding, for example, either in the instance of condensing or of non-condensing engines. The case is hardly well settled in the former case, and scarcely at all in the latter, and in both cases, so far as settlement has gone, it has been by the slow process of experiment rather than by the quick process of mathematical demonstration. It is perhaps true, as is often said, that work-a-day engineers and mechanics are not inclined to take kindly to mathematics, but they would take it in (to them) heroic doses if administered to a really useful and *conclusive* purpose. In steam engineering, mathematics can hardly be so administered. The point is that in all these years knowledge enough in the behaviour of steam has not been crystalized to put most of the questions in relation to compounding beyond the domain of experiment.

The consideration of condensation, we are told, not before but after the fact, tells all in favor of compounding, but as to how and to what extent (how we shall apply figures to various conditions), we are just about as much in the dark as we were fifty years ago. We cannot use the reasoning that we apply to one set of conditions, modified according to some well established law, to another set with any degree of certainty, except the (almost) certainty that we shall be wrong. We want to apply them in every-day practice to the determination of something that is, and not to the determination of something that might be were it not for the *if* in the question. To state it another way, we cannot apply figures to help in the problems of every-day steam engineering as we ought to be able to do. It would seem that enough should be known of what constitutes the elements of economy in compounding to permit this with reasonable exactness, but such is clearly not the case.

We need not go even so far as compounding to find ourselves at fault. Take the employment of steam at high pressure, say 400 pounds per square inch. Whenever attempt has been made to approximate this pressure, it has been made quite certain that we are not, before trial, in a condition to tell anything about the results that will probably be obtained from the steam itself. The mechanical detail may with entire confidence be left to the mechanic for solution. If such economic results, as figures show to be probable, were obtained, all objections to the use of high pressure steam would soon cease. But such results do not

obtain. The figures are wrong—entirely wrong; but how and why wrong, are questions that puzzle the wisest engineers.

Consider steam as it is ordinarily employed, that is, within the limits of 160 pounds pressure. Assume that we build a simple engine to use steam of 80 pounds pressure and that by actual trial it is found that the most economical point of cut-off, considering coal consumption, is at one-quarter stroke. We build another engine on the same lines to use steam of 40 or 160 pounds pressure. We are very much, or at least, quite too much in the dark as to what the most economical point of cut-off will be. The same is true of compression and other things that affect the economical use of steam.

It is too much to expect that all this can be changed at once, but is it not probable that by the painstaking effort of collecting the records of as many reliable tests as practicable, tests in which all conditions of both construction and operation are known, a series of curves might be plotted without reference to or regard for "laws" or anything of the sort, that would be better for the hard-working, "practical" man, than all, or at least most, of the knowledge we now have on the subject? It looks as if the matter was worth thinking about. Such curves would not be "scientifically exact," but they would be better in this respect than no sort of exactness. F. F. H.

* * *

EVERY-DAY SHOP SUBJECTS—5.

CHIPS.

NEW LATHE DESIGN—A BELT HOLDER.

One of my shop-mates came to me the other day and wanted my opinion of a sketch he had for a lathe. I recalled the amusing and pointed remarks made some months ago by Mr. I. Podunk on the subject of consulting engineers, and was about to demand a fiver in advance, but relented and consented to look at it.

The designer had been having trouble with his lathe from chips getting under his carriage, so he schemed out a lathe like Fig. 1. This is a cross-section view, and I'll try and give his explanations.

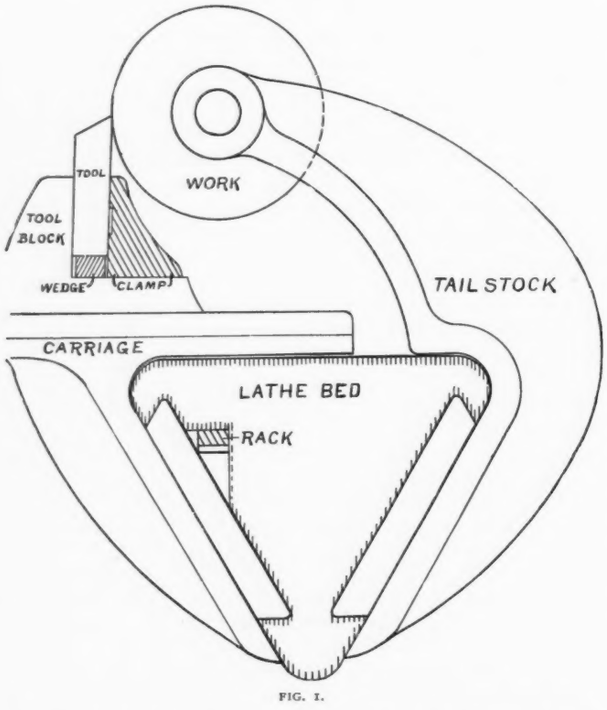


FIG. 1.

"The bed is a triangle, and can be solid or cored as preferred, probably cored, and larger in proportion to tail stock and carriage. The 'ways' are both out of the way of dirt and chips. The tail-stock fits in back ways—carriage in the front ones. The rack for feeding carriage is shown, let into bed; this is only a suggestion. The swell front of carriage allows for the gearing. The tool is held in a vertical position as shown, being in a good position to be supported by carriage. The sketch shows the work a little forward of the center, perhaps too much so; this is only a rough sketch, however. Fig. 2 is a plan view of tool block. A wedge for adjusting height is shown in Fig. 1. Fig. 3 is an enlarged view of a detail of the carriage, being a hub or boss for such of the handles on the front of the carriage as need to turn all the way round."

This is sort of a novelty in lathe design, and may bring out some other ideas. I don't think it is patented, and am pretty sure it won't be, at least, by this man. How would it do for a grinding machine? The "ways" would be out of the dust, and by putting the centers back further, neither the wheel carriage nor the work would overhang but very little.

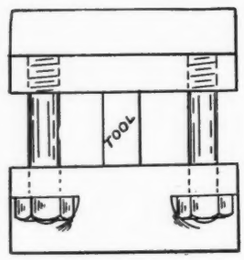


FIG. 2.

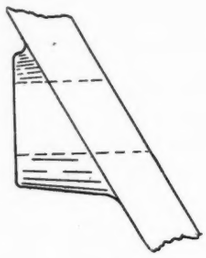


FIG. 3.

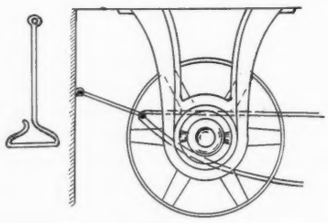


FIG. 4.

A friend of mine is a kind of a crank on shafting and belts, and it makes him ache to see a belt hanging loosely on a shaft. Sometimes this causes an annoying little squeak and it almost always leaves a band of black on the shaft, from rubbing on the belt. So he has fastened hooks behind all the pulleys whose belts are liable to be thrown off, and when the belts go off, they are slipped into these hooks and held away from the shaft. Fig. 4 shows both a hook and the belt hanging from it. They are not much trouble to make and put up, and though they may be a fad of his, they certainly keep a shaft looking better, and looks really count for something in the shop after all.

* * *

A FEW FACTS ABOUT LAG SCREWS.

I. B. RICH.

While there are few lag screws used in regular machine work, they are still quite a factor in erecting new machines, as they are frequently used in fastening countershaft hangers to the stringers above the machines, or for fastening tools to floor to prevent their being moved.

Incidentally, this latter case often causes trouble, as the lathe or other machine is screwed down hard, regardless of the floor being out of level, and the machine is sprung out of truth in some part. This is nothing against the lag screw, however, only the man who doesn't use it correctly. For overhead work, and in any other case, I prefer "through bolts" to screws, but as screws will be used and answer well enough in many cases, it is convenient to know a little about them, how much they will hold, etc., as it isn't pleasant to have a countershaft make a grease spot on your cap by dropping on your head, from the screws not holding it up in place.

The following table has been compiled from various authorities and should be in the note book of every mechanic who ever has any use for lag screws. It explains itself:

WOOD OR LAG SCREWS.

Diameter, inches.	Threads per inch.	Length of Thread, all diameters.		Test of Drawing out of Yellow Pine		
		Length of Bolt, inch.	Length of Thread.	Diameter.	Depth in wood.	Drew out at, pounds.
5/16	9½	1½	To head.			
3/8	7	2	1½	½	3½	4 960
7/16	7	2½	2	5/8	4	6 000
½	6	3	2¼	¾	4	7 685
9/16	5	3½	2½			
5/8	5	4	3			
¾	4½	4½	3½			
⅞	4½	5	4	⅞	5	11 500
1	3	5½	4	1	6	12 620
1⅛	3	6	4½			
1¼	3	7	5			
1⅜	2½	8	6			
1¾	2½	9	6			

FROM ACTUAL PRACTICE.

"MILO."

MORE MACHINE SHOP HASH.

Where is there a machinist who has not seen the time that a double angle iron, similar to Fig. 5, would have been a welcome thing to find? It would have been just the thing for holding that eight-cornered piece he was working on the other day, also that round stock that had to have a hole bored down through one side, like an eccentric.

About one machinist in a hundred, possibly more (probably less), has been able to find such a thing in the shop where he worked, when he wanted it. Business isn't very rushing just now, Mr. Nay; you ought to let the pattern-maker get one out for use on the face-plate especially. The slots in the base for bolting it down permits sufficient adjustment so that the center of a hole can be placed anywhere within the line A A, a radius

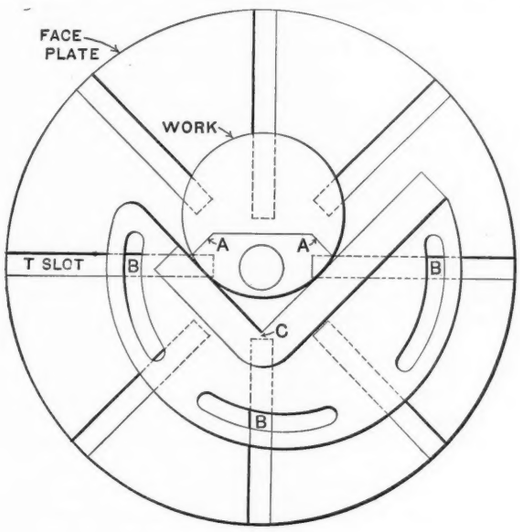


Fig. 5

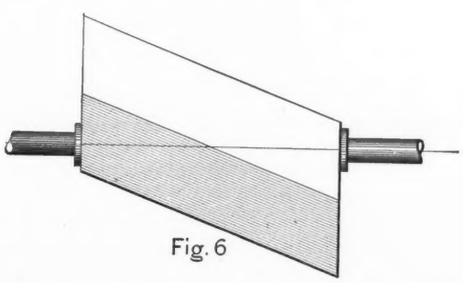


Fig. 6

of 3 inches or more from C, without changing any of the three bolts B from the T slot in which they are placed. The work shown in position is about 5 inches diameter on a 16 inch face plate.

A "tumbler" is a familiar thing to machinists, but for small work the one I saw the other day at T. W. Spark's Shot Tower in Philadelphia, for polishing bird shot, would be a novelty and an improvement in dozens of shops that I know of.

It is a plain square box with the ends cut off at right angles to the shaft which passes through it at an angle as shown in Fig. 6. When it revolves, first one end is up and then the other, giving the contents a motion from end to end in addition to that usually produced in a tumbler, or rattler, as it is sometimes called. The same construction is also said to make an excellent churn for cream, and quite extensively used in some localities.

In one shop where I used to work were two lathes set close together. Almost every time the chuck or face-plate was put on to one of them a piece of dirt or chip would get wedged into the threads and cause trouble. This had happened so often that the threads were badly injured, while the other one gave no trouble in this repect. Why? Because when it was first put into the shop a notch was filed in the end of the spindle as shown in Fig. 7. The notch was located just where the chamber run out, leaving a full thread. Now when the face-plate was screwed on, there was the blunt end of a full-sized thread A, like the tooth on a tap, which scraped out the dirt as it went along, just the same as a tap would. Certainly, it is an old trick, and if I was foreman I would have every lathe in the shop fixed that way.

Some men think there is nothing so good as a fine pointed thread tool to test a piece of work in the lathe to see if it runs true, and I have seen good arbors and finished work all scratched up by them in making such tests, when a tool like Fig. 8 would have been just as good if not better, and would not have left a scratch. It is nothing but a piece of good hardwood about the size of a tool shank, with a small piece of brass wire (pointed so as to make it drive tight) driven into the end of it. Make one and try it. Chalk the surface of the work and it will leave a better mark.

Turning shafting or other work so slender that it is necessary to use a center rest, is one of the every-day jobs in a machine shop, and the apprentice soon learns that in most cases it is best

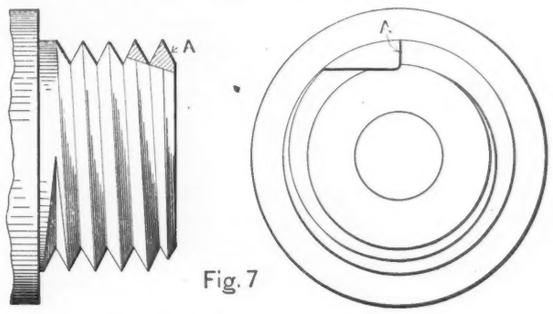
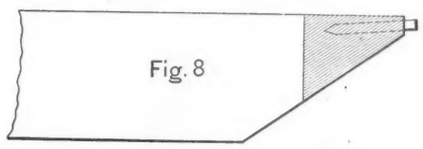


Fig. 7



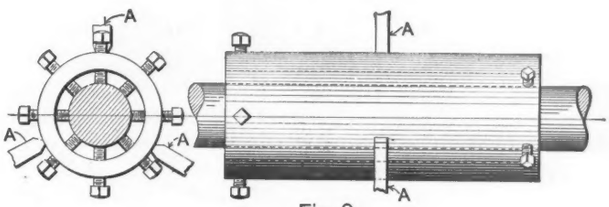


Fig. 9

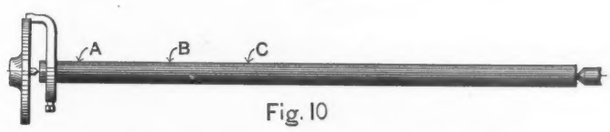


Fig. 10

to put the spot for the rest just a little (an inch or more) nearer the face-plate end of the work, instead of putting it exactly midway between the centers; because when he has finished as much as he can get at on one end and changes the work end for end, all of the unturned part can be gotten at with the tool without moving the center rest. Getting a good true spot for the rest is the part that bothers the beginner most. If he is a bright boy he will frequently try to turn a small spot where he wants it, by taking very light chips and fine feed with a sharp-pointed tool, which is often practicable, but he will find many cases where it is impossible to do this, as the work is so long and slender that it will climb up on to the tool, chatter and spring.

There are at least two practical methods in common use for overcoming this. The first is by using a bushing, Fig. 9, with three or four set screws in each end by which it can be adjusted on the rough or crooked shaft so that at least some part of the outside of the bushing will run approximately true, which serves as a spot for the center rest. Such a bushing as usually made has more or less "give" to it, and is also apt to be drawn out of shape somewhat by the adjusting screws, which are some of its objectionable features. For this reason the screws on one end should be placed between, instead of directly in line with the screws on the other end, which would lessen to some extent the evil effects of the screws upon its shape.

The second method, which is always at hand, does not seem to

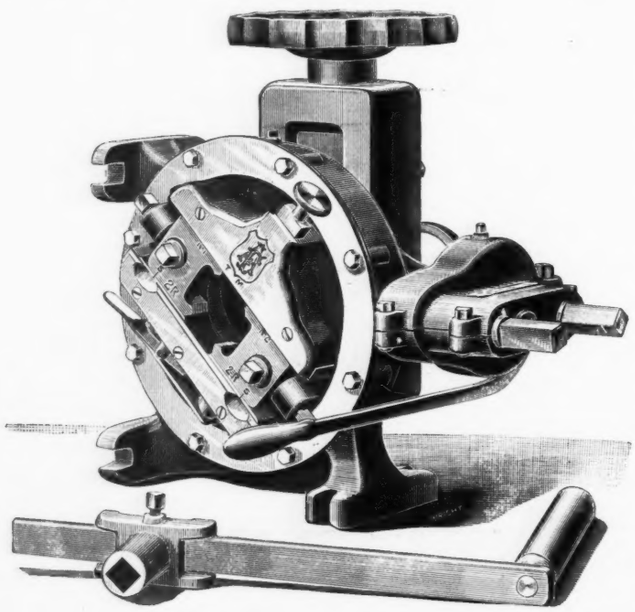
be so well known as it should be. It is often the most satisfactory, although there are cases where it is not. First spot A, Fig. 10, is carefully turned near the face-plate end of the work, where it is stiff enough to stand it properly, then the center rest is put on and adjusted to steady it, and another spot B is turned and the rest moved to that and so on, until the point where it is desired to locate the rest is reached.

* * *

NEW ARMSTRONG PIPE THREADING MACHINE.

The machine here illustrated is the outcome of frequent calls received by the Armstrong Manufacturing Co. for a machine threading from ¼ to 2 inch pipe. It will be known to the trade as Armstrong's No. "O" pipe threading machine, and uses the well-known regular Armstrong adjustable dies which are put in the machine and adjusted in the same manner as in the hand stock. These dies can be opened after cutting a thread, and when the pipe is removed, may be locked back to the standard size with precision. This is accomplished by an automatic locking device which is operated by simply pulling a knob. The dies, however, can be adjusted to the variations of the fittings, the same as in the stock.

All the gears and moving parts of the machine are run in oil, being enclosed in a chamber which covers and protects them from chips and dust, doing away with the possible chance of chips and dirt getting into the gears. The machine is self-oiling in all its parts, oil being admitted through two holes which are closed by screw plugs.



The die-head has no teeth on the part where it fits into the shell and forms a bearing, in this way preserving its bearing surface and making it impossible to get loose. In addition to the die-carrying head forming a bearing in the manner shown, it has an inner journal, thereby increasing its wearing surface.

The construction of the machine admits of its being adjusted to a post on the side of a building or on a bench. This is a very desirable and an entirely new feature, and one that is found in no other tool of its kind. Another, and one of the principal features of this No. "O" machine, is its two speeds, a change from one to the other being effected by merely removing the crank from one spindle to the other. In one case the operator can cut from ⅛ to 1 inch pipe, inclusive, with great rapidity, then by changing the crank to the other speed, from 1¼ to 2 inches inclusive, thus avoiding the necessity of turning a great number of times on small size pipe.

To operate the machine, the vise is pushed back and the pipe located in the mouth of the dies, then by pressing the feed lever and turning the crank the pipe is fed into the dies. When the pipe is flush with the dies, the small lever shown on under side of die-head in the engraving is pressed toward the die which releases the locking device, and by pressing the knob on opposite side, the dies are thrown open. If the vise with the pipe is then pulled back and the knob pulled out, the dies are re-set ready for threading another piece of pipe. The locking device adjusts itself automatically.

As this machine uses the regular adjustable dies, it can be furnished with dies for threading pipe from ⅛ to 2 inches, either right or left, or with bolt dies for threading from ¼ to 1½ inch rod, inclusive, also with dies for threading brass tubing and conduit pipe.

Any further information which our readers may desire will be gladly furnished by the Armstrong Manufacturing Co., either at their factory in Bridgeport, Conn., or their New York office, 139 Centre street.

* * *

SOME PHILADELPHIA SHOP NOTES.

In a recent visit to some of the Philadelphia shops, the writer noticed quite an extensive use of the interior telephone for communication between departments, and in every case it was highly spoken of as a time-saver, and it might be added—a leg saver as well.

Its convenience is not confined to shops of many stories, separate buildings, or various rooms, although it is more of a necessity in the latter cases. But even in shops like the Newton Machine Tool Co., which consists principally of a main floor and a gallery, it is more convenient for any one in the gallery to step to the telephone and communicate with the department down stairs, than to lean over the rail and shout himself hoarse after he has attracted the attention of the one he wishes to speak with, by gently tossing a spare bolt or nut, at his feet or head. The telephones are not luxuries in these cases, but actual necessities when time is considered, as it should be in nearly all cases.

In shops like Edwin Harrington & Sons, the time saved is more apparent, as, being more in the center of the city, the shop is distributed over several floors. The telephone practically annihilates distance for ordinary conversation and consultation, and leaves the energy, which was previously expended in climbing stairs and tramping over the shop, to be used more advantageously.

They are comparatively cheap to install, the cost averaging about $15 per station, and as all of the shops using them seem to consider it money well invested, it can be classed as one of the necessities of the modern shop as soon as it out-grows its first small room with the lathe, a shaper and a drill press.

The telephones are put to a good use in the Harrington shops in helping to get the tools from the tool room to the men. There is usually much time wasted in going to and from the tool room and in waiting for "turns" at the window.

Instead of tramping over half the shop to get tools, the workman goes to the nearest 'phone, rings up the tool room and tells what tools he wants. These are picked out and sent to him by a boy, who leaves the new tools, takes back the ones he is through with, and exchanges checks if necessary. The boy gets an idea of the various tools used in the shop, the man saves shoe leather and legs, while the firm saves time and secures a greater production per machine or per man than before; so it's a gain all around.

This is one of the hard times economies which help reduce the cost of production. The 'phones cost about $150, but this has been saved many times over.

The tool room of the Newton Machine Tool Co. is entirely different from most tool rooms, with several good points to recommend it in a shop of this location; and conditions must always be considered if best results are to be obtained. They make few tools as compared with shops manufacturing a regular line of goods, for in a measure their products are special and cannot be made in large quantities.

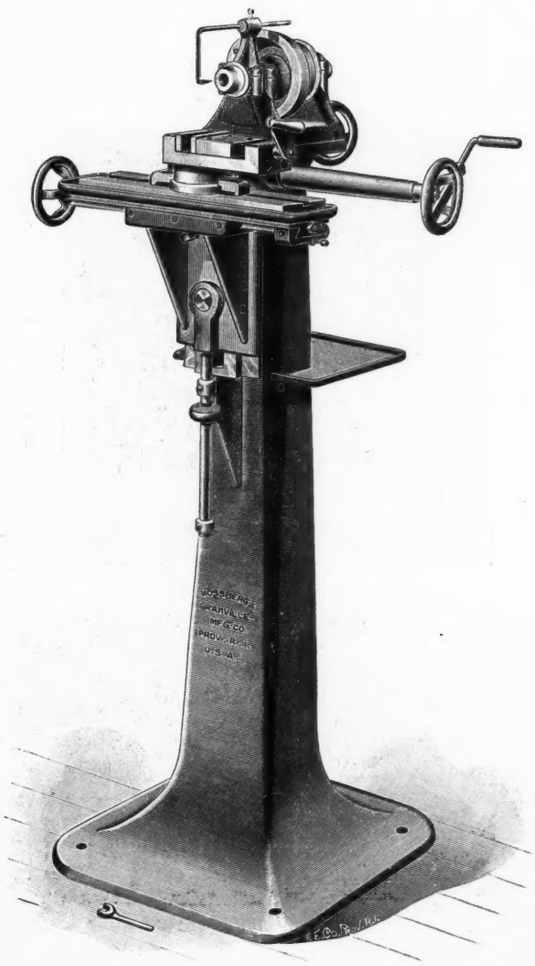
The tool room is simply a place for storing and sharpening tools, and hasn't a lathe in it, simply grinding machines. When tools are wanted they are made to drawings by the best machinists in the shop, just as any other regular work is done. This is found to be the most economical procedure in this case, and might apply to some other shops as well.

* * *

We have been favored with a copy of a table of screw threads and decimal equivalents, which is very convenient and contains much information in a small space. It gives outside diameter, diameter at bottom of thread and effective area of both U. S. S. and V threads. It is sent free to all who have use for it by Otto E. Evans, York, Neb. Although Mr. Evans does not say so, we suggest that a stamp be sent with the request.

SOMETHING NEW IN MILLING MACHINES.

The illustration shows a new type of a small milling machine that has some very good points in construction, and a machine that is easily and quickly handled. It is adapted for both manufacturing and small tool making where a handy, compact, sensitive milling machine is required, and is liked by both the manufacturer and operator. The pointer shown at the top of the machine is for use in milling out dies for press work, the end of the pointer showing the position of the milling cutter even when the latter cannot be seen, and is especially desirable when undercutting or backing out a die, so as to remove the stock and avoid the necessity of too much filing. The machine can be handled by the operator while sitting in front, as all three hand wheels can be easily reached without the necessity of the operator changing his position, or taking his attention from the pointer.



Stops are provided on both vertical and horizontal feed. The end thrust of the spindle is taken by gun metal collars, the end wear being taken up by two chuck nuts. The bearings for the spindle are of ample diameter and length, capped in the usual manner.

The centers have a capacity of 5 inches diameter and 6 inches long; cross feed of table, 12½ inches; vertical feed of table, 8½ inches; greatest distance from table to center of spindle, 8½ inches; movement of head at right angles to table, 3¾ inches. Index head graduated to 90 degrees. The hole in the spindle is Brown & Sharpe's standard taper No. 7. Weight complete, 330 pounds. Height over all, 50 inches.

A complete set of tools, cutters, arbors, etc., can be purchased with this machine, which is built by the Mossberg & Granville Mfg. Co., Providence, R. I.

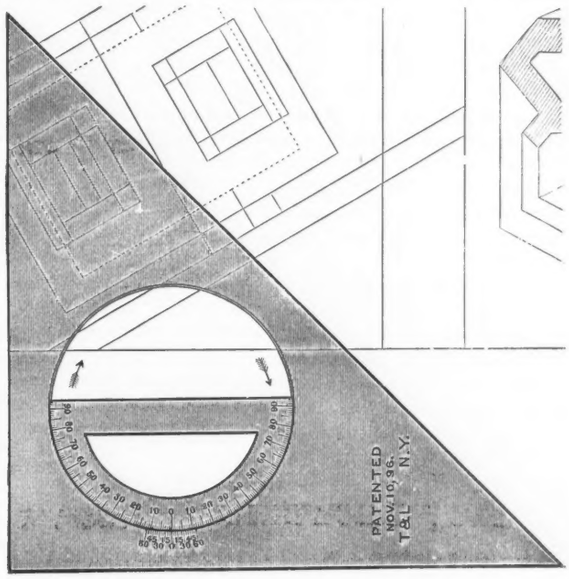
* * *

We have received another list of articles which are said to be sorely needed by the general public. There are 200 alleged inventions named, most of which are about as necessary as a double-ended mule, and some asked for are about as feasible as hot ice, or a cake that you can eat and keep too. This list also hails from Washington, which seems to furnish a good crop of patent agents of this breed.

* * *

COMBINED TRIANGLE AND PROTRACTOR.

This is a very simple and at the same time a very useful device, being extremely handy for ordinary drafting work requiring definite angles. It is an 8-inch triangle of transparent celluloid,



containing a protractor as shown, this being held in place by a spring. The device needs no further description, as its good points can be seen at a glance. It is handled by Tower & Lyon, 95 Chambers street, New York, and illustrated on page 20 of their new catalog.

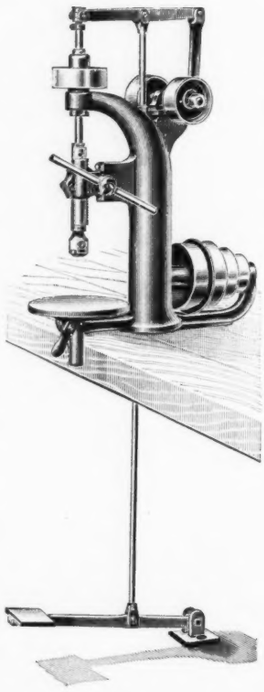
* * *

A NEW DRILL CASE.

This is one of the conveniences which soon become necessities in the modern shop. The keeping of drills in get-at-able shape is quite a problem, and while the old wooden drill block is very convenient and safe, it usually provides a place for only one drill of each size. This case holds a large quantity of drills, about 16 of the largest size and 200 of the smallest size, and is equally convenient for shop or store. It is a casting, having round bot-

tom compartments and a hardened steel bushing for each compartment, making a drill gauge which does not get lost or misplaced. In addition to this the number of the drill, the size in decimals and the size of tap, for which this drills the right size of hole is given. Every drill can be plainly seen and readily taken out for use. The cover is so arranged that it cannot be slammed down, and is easily raised with one finger. It is made by Weiss Bros., 288 Graham street, Brooklyn, N. Y.

NEW BENCH DRILL.



This has recently been put on the market and is the latest production of the Geo. Burnham Co., 15 Hermon street, Worcester, Mass. It has several special features to recommend it, among them being larger capacity than is usually found in this class of machine, drilling holes up to ½ inch in diameter. The spindle can be moved its entire range of 5 inches by the foot lever shown, leaving both hands free for the work. If desired, the hand lever can be used instead.

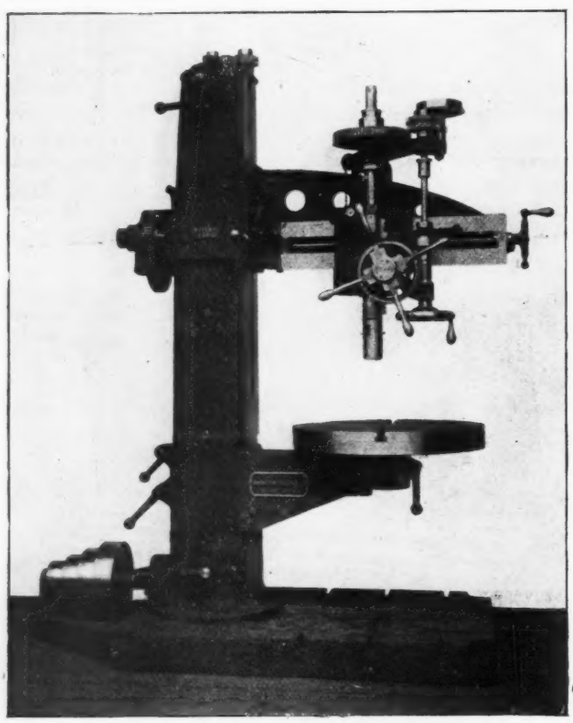
A universal drill chuck is furnished with each machine, and, as it tightens with a key, the spindle need not be held, as it has no tendency to revolve. It will drill to the center of a 13-inch circle, and has an extreme clearance of 8 inches between chuck and table. The table also has a vertical adjustment of 5 inches.

There are many shops where such a drill as this would be more economical than the larger ones now in use.

* * *

COMBINATION RADIAL DRILL.

The radial drill shown with this is said to represent the outgrowth of a most careful study of modern needs for such a tool, by those who have been most intimately connected with drill press work for a number of years.



DRESES, MUELLER & CO. RADIAL DRILL.

The frequent changes of speed which occur in drill press work make it necessary to provide convenient and rapid means for making these changes, if the machine is to be successful and popular. This feature has received careful attention in this machine and all changes of speeds, with or without back gears, as well as reversing spindle, can be done quickly and quietly by the handle in front of the arm.

The spindle driving friction-clutch can be adjusted for tapping so as to slip at any desired strain, making it easy to use bottoming taps without fear of breakage.

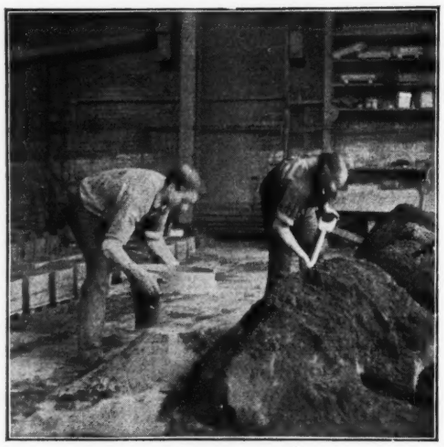
There is a novel quick return, and the feed can be changed without stopping drill. The column is arch-shaped and revolves on steel balls. The arm is elevated by power and slides on a flat surface, insuring proper alignment. The table-arm can be swung clear around the column and the table also revolves on its bearings.

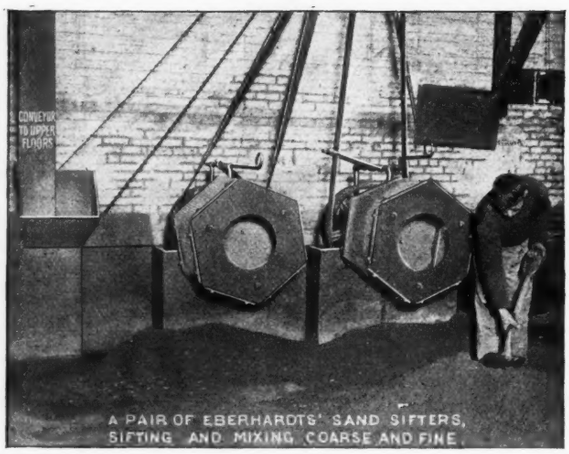
Two sizes are made at present, 62-inch and 96-inch swing, with square base. They weigh 3 000 and 4 500 pounds respectively. Dreses, Mueller & Co., Cincinnati, O. are the makers, and will give any desired information.

* * *

SAND SIFTERS.

The foundry is too often the last place to be thought of when new machinery and appliances are being ordered, and considerable money is lost every year on this account. The two engravings so well illustrate the difference between old and new methods of sifting sand that little or no description is necessary. The first shows the two men who had to work ten hours a day to sift sand





A PAIR OF EBERHARDTS' SAND SIFTERS, SIFTING AND MIXING COARSE AND FINE.

enough for Gould & Eberhardt's foundry, and it was hard, back-breaking work, besides costing too much money. The second view shows a pair of sand sifters which, with the aid of one laborer, sifts all the sand they need in two hours, leaving one man and eight hours of the other man's time to be used elsewhere.

They are manufactured by Gould & Eberhardt, Newark, N. J., to whom all inquiries should be addressed.

* * *

"It is not necessary for us to say how eagerly *The Railway Age* welcomes any evidence of increasing cordiality in the relations of the companies and their employes."

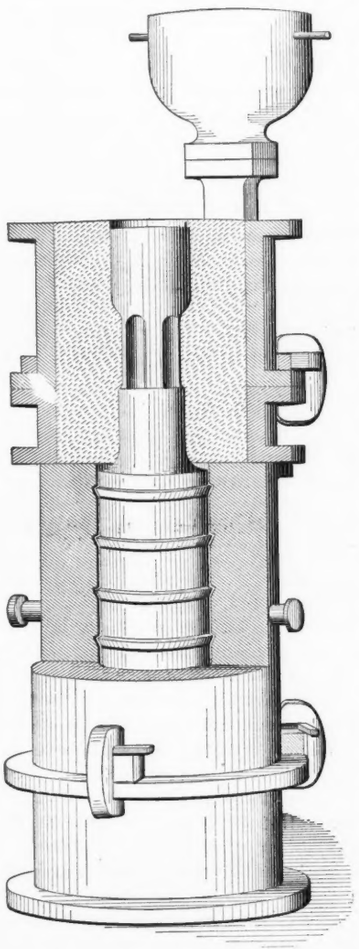
This is a prelude to an advocacy of the Brown system of discipline, which we have mentioned and endorsed several times. The amusing part is that *The Railway Age* has long been noted as a paper which invariably sides with the railroad corporations, regardless of the question at issue, and which is probably as thoroughly hated by railway men as any paper can well be.

ITEMS OF MECHANICAL INTEREST.

CASTING CHILLED ROLLS.

The Lewis Foundry & Machine Co., Pittsburg, Pa., have patented a new method of casting chilled rolls, which, it is claimed, secures an even depth of chill instead of a varying one, which is too common and which leads to broken rolls from unequal expansion after being heated by the work. Speaking of the causes and remedy, this company say:

"Just as soon as a roll mould is filled with molten iron the operation of casting is at an end and the cooling and contraction of the roll within begins; soon after, the molten iron in the upper end of the mould begins to sink, that is, in that surplus portion which is cast on the upper end as a reservoir for the time being, and called the 'sink-head,' and which is afterward cut off. From time to time as the sinking goes on, fresh molten iron from hand ladles is poured into the sink-head, and thus demand and supply for more hot iron goes on until later, when as no further sinking takes place, no further hot metal is needed. It is now that the iron is passing from a molten condition to solidification. Of course the whole casting is shrinking within its mould. The length is shortening, and in diameter the body of the roll is leaving the walls of its chill mould. The final and correct theory was, that in shrinking, the roll body did not leave or depart from the walls of the chill mould equally, but that it would often lean more to one side than to the other—that it would 'cleave to one and leave the other.' If this was correct, then that side of the chill mould with which the roll body would remain in contact, would produce deep chill on the roll, and that side of the roll body which would depart from its chill mould, would have a shallower depth of chill.



"How to compel a roll while in the earlier part of the period of its contracting, to remain centrally within its mould, and departing, to leave it equally all round, so that during the two, four, six or eight minutes (more or less) in which the chill on the roll is forming, the roll should be sustained equi-distant at all points from the walls of the chill mould, was the problem. The movement of the roll itself in contracting must do it; this alone could be the proper plan.

"With this object in view, the usual "chills" in which the bodies of the rolls are made, had a number of notches or recesses formed on their inner surfaces and near to their upper ends, so that when the cast should be made, these notches would form corresponding projections on the surfaces of the roll bodies. The projections were made to have their lower edges beveled or inclined downwardly, so formed by the shape of the recesses that produced them. Now, as the roll made in such a chill mould would begin to sink at its upper end, it would at the same time diminish in diameter; in other words the roll would leave the walls of its chill mould. When leaving its walls, inwardly and downwardly, the beveled edges of the projections on the body, bearing the beveled edges of the recesses of the mould, would from all sides compel the roll in shrinking, to depart evenly and alike from the walls of the mould toward the center. These would cause the casting to maintain a central position while the chill on the roll was being formed during solidification and contraction. After a number of rolls had been successfully made, a greater number of these notches were added, so that being closer together, more certainty would be established. This was done and the result was still better. Next, if a series of closely formed notches served well, why not make a continuous recess—a small groove around its circumference on the inner wall of the mold? This was done and the ridge or band thus formed on the upper end of the roll body served even better than all else. Now, as long and short rolls are, from time to time, cast in the same chill mould, why not make a number of small grooves on the inner side of the mould—say from the middle to the top, to form an equal number of ridges or bands, on the roll body? This was also done and the result was a perfect roll. The means here described of supporting the roll during contraction, also prevents the rupture or cracking of the surface, and admits of the use of stronger irons, higher in shrinkage than weak irons, hence adding to the strength of the rolls.

"Note, particularly, that any projection that may be cast on the surface of a chilled roll must not project from its body to such a degree as will prevent the chill mould from being lifted up and off from the roll casting, as it stands in the casting pit, after the roll has cooled and contracted within."

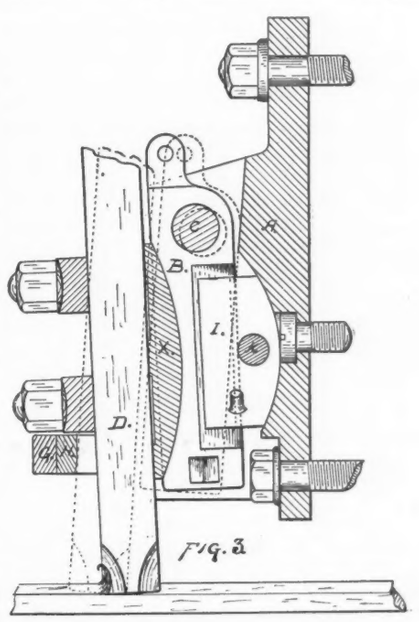
This is said to produce a practically straight roll, having such an even chill that $\frac{1}{16}$ of an inch is sufficient to true it up.

* * *

A DOUBLE ACTING PLANER HEAD.

Although some of the older planers used a head which reversed so as to allow the tool to cut on the return stroke, and others used two tools, one for each stroke, the modern practice is to use but one tool and cut but one way, but to run the table back at as high a speed as practicable. That some thought is being devoted to the double action idea is shown by the device of Joseph A. Costello, of Cleveland, Ohio, which we illustrate. While this is not the only device of the kind, it is said to be the least complicated of any and has been tested in every-day work by the inventor.

In the accompanying cuts A is the apron frame, which is attached to cross-rail in the usual manner. B is the tool-bearing apron, having its back side beveled to conform to faces of wedges I I (see Fig. 4), so that when the apron and attached tool are swung into the rear position the apron conforms to the ample bearing surface afforded by the wedges. These wedges limit the rear swing of apron B and the attached tool D. They are connected by a right and left hand threaded screw K and are moved by it and clearance given to the tool when in its rear cutting position, and they also serve to correct any imperfection in the grinding of the tool, which has double cutting edges.



It is obvious that both cutting edges in a tool of this kind should have the same depth of cut in their operation, and unless provided with some means of adjustment would have to be reground. X (Fig. 3) is a plate which forms a rear bearing for the tool, and is used to set its cutting edges at the same elevation. G is a stop limiting the forward swinging movement of apron B and attached tool D. H is a wedge suitably arranged in stop G to relieve the strain on tool-clamping studs. Spring O aids the pin in returning the apron and tool into their perpendicular or nor-

mal position, preparatory to the tool's engagement by the work when the tool is not in operation. C is an eccentric shaft upon which apron B swings, and it is also connected by levers P and Q to the upper end of the apron. It serves to retain either one of the tool's cutting edges during the movement of said edge into its operative position at the same elevation at which it is held in the perpendicular or normal position, thereby enabling the attendant to reverse the work at any point between the ends of the work's stroke without altering the depth of cut or mutilating

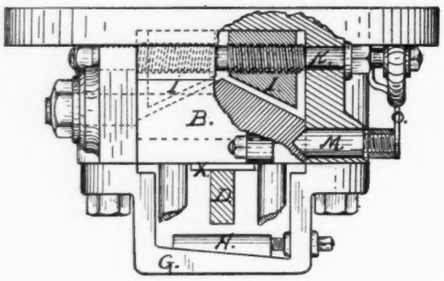


FIG. 4.

the work; for it will be seen that if shaft C were a plain shaft the forward cutting edge would be lowered during the rearward swinging movement of the tool bearing apron, and the rearward cutting edge would be elevated during the forward swinging movement. This is overcome by the arrangement described. Angular pins L L are arranged to preserve at all times a parallelism between front side of wedges I I and back side of apron B during any adjustment of the wedges.

This head can be converted from a double acting to a single acting head, same as in use to-day, by disengaging forward end of lever P from apron B, and drawing wedges I I tight together by means of screw K, thereby forming a solid backing for apron B, which also brings the apron into perpendicular position. Then remove stop G by slightly loosening nuts which secure it, and lastly, disengage pin M.

* * *

HOW AND WHY.

A COLUMN INTENDED TO CONTAIN CORRECT ANSWERS TO PRACTICAL QUESTIONS OF GENERAL INTEREST. GIVE ALL DETAILS AND YOUR NAME AND ADDRESS, WHICH WILL NOT BE PUBLISHED UNLESS DESIRED.

29. X. Y. Z. How is a hyperbolic curve drawn? *A*. There are several ways of drawing a hyperbolic curve, a number of which were shown in the issue of June, 1896. The cut with this shows a very common method as applied to the expansion line on an indicator card, showing the cut-off at one-fifth stroke. The curve, however, starts at T, and this is the point we must consider. Divide T R into any number of equal parts, four in this case, *a*, *b*, *c* and R. Draw straight lines from these to O, as shown. Where these lines cross T S, as 1, 2, 3 and 4, draw hori-

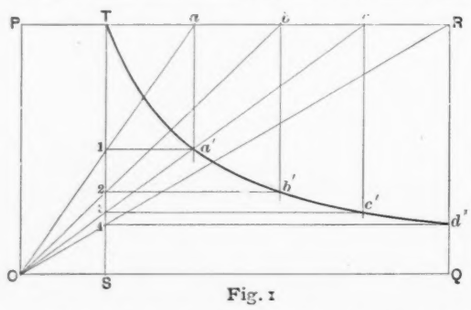


Fig. 1

zontal lines till they cut or meet vertical lines dropped from *a*, *b*, *c* and R. Through these intersections a^1, b^1, c^1 and d^1 draw an even curve as shown, which will be a hyperbolic curve. Another and perhaps simpler method is shown in Fig. 2. According to Mariotte's law, all perfect gases expand so that the pressure varies *inversely* as the volume and *vice versa*. In other words, as the volume increases the pressure decreases in exact proportion, or as the pressure increases the volume decreases.

Let the rectangle equal the volume of the cylinder and assume that steam is cut-off when the piston reaches 1, this, then, is the volume of the steam at a pressure represented by the height of line 1. When the piston has traveled to 2, it is evident that the volume of steam in the cylinder is twice what it was before; consequently the pressure is one-half the original, making line 2 one half the length of line 1. The same is true of all the points: at 4 the volume is four times the original, and the pressure one-fourth. The terminal, or line 6, is one-sixth the pressure, because the steam now occupies six times the volume. Drawing a

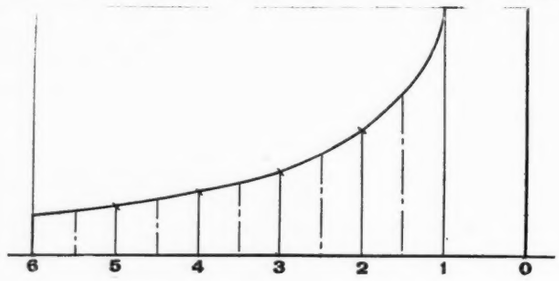


FIG 2.

curve through all the points shown, gives a hyperbolic curve. This is simpler than some methods and easily remembered, because it can be readily seen *why* it is done. The more divisions we make, the more accurate the curve.

30. H. S. G. What is the best book giving information about lettering drawings? *A*. The best book we know of which pays particular attention to lettering, is "Lettering for Draftsmen, Engineers and Students," by Chas. W. Reinhardt. Price, $1.00. The D. Van Nostrand Co., Publishers, 27 Warren St., N. Y. City.

* * *

WHAT MECHANICS THINK.

THIS COLUMN IS OPEN FOR THE EXPRESSION OF PRACTICAL IDEAS OF INTEREST, TECHNICAL OR OTHERWISE. WRITE ON ONE SIDE OF THE PAPER ONLY, AND BOIL IT DOWN.

WHEN SKETCHES ARE NECESSARY TO ILLUSTRATE THE IDEA, SEND THEM ALONG—NO MATTER HOW ROUGH THEY MAY BE, WE WILL SEE THAT THEY ARE PROPERLY REPRODUCED.

WATER TUBE VS. SHELL BOILERS.

In the March issue, Mr. W. Barnet Le Van takes exception to the writer's opening remarks in his recent article on "Systematic Boiler Designing," saying that "If Mr. Norris will consider the number of persons injured and killed by the use of the water tube boilers, in comparison with like casualties by shell boilers, he will find the former to be equally destructive; and as to the economy in fuel, the shell boilers will excel the water-tube boilers. In proof of which statement Mr. Le Van cites the tests made at the Centennial Exhibition in 1876, one made at the Brush Electric Light Company, Philadelphia, in 1882, and one made by Mr. Geo. H. Barrus at the Keystone Watch Case Co., also of Philadelphia, in 1888.

Excellence, in everything, always makes interesting reading, and is usually sure of winning a place in history; but the mere fact of an incidence becoming history, immediately proclaims it an exceptional case, but exceptional cases do not furnish the right kind of data on which to base a rule, and all should know that the water-tube boiler is *infinitely* safer than the shell boiler.

In preparing the article in question, my sole object was to indicate the successive steps, or mode of procedure, when considering the design of a complete *water-tube* boiler, and not to enter into a discussion of the relative merits of the various types on the markets, but I should like to ask Mr. Le Van why he choose the particular tests in question to illustrate his argument. The Centennial trials were made when the water-tube boiler was in its infancy, and are now twenty-one years old; the Brush Electric Light Company's test is fifteen years old, and the last, an exceptional case, or, to use Mr. Barrus' words: '*specially good.*' But notwithstanding the youthfulness of the water-tube boiler in 1876, Mr. Le Van will find upon making a more careful examination that, *of the five boilers which gave the best results at the Centennial, only one was a tubular boiler—three being water-tube boilers, and one a combination of the two types.*

Again, if Mr. Le Van will review the economy trials made by Isherwood, and will compare his tests upon horizontal fire-tube boilers (seventy-three in all) with a like number made upon water-tube boilers, he will find that *the average equivalent evaporation per pound of combustible of the fire-tube boilers*

is 11.00 lbs., as against 11.66 lbs. for the water-tube boiler. further, that the highest result obtained with the fire-tube boiler was only 13.60 lbs., as against 14.86 lbs. with the water-tube boiler, which clearly proves that Mr. Le Van 'did not have the facts before him' when writing his 'Water-Tube *vs.* Shell Boilers.'

The fact of the majority of water-tube boilers having 'a large shell over the top in which the steam is disengaged from the water, commonly known as a steam drum,' has very little to do with the destructive effect of an explosion, as fully shown by the experiments of Regnault, Fairbain, Tate and others. The action of the steam which may happen to be present in the steam chambers of a boiler at the moment of rupture, is considered unimportant by all good authorities. It is the enormous quantity of energy stored in the water which, upon sudden liberation, causes the frightful loss of life. Conclusions derived from an experiment by Mr. Geo. Biddle show that "the destructive energy of one cubic foot of water, at a temperature which produces the pressure of 60 lbs. to the square inch, is equal to that of one pound of gunpowder. Therefore it is not difficult to understand why the sectional boilers, in which the water is divided into small compartments, is so much safer than the shell boiler—it being tolerably certain that any rupture will be local. If a tube or other part bursts, it usually acts merely as a safety valve, discharging the contents without danger to either life or property. A violent explosion can only come of the general disruption of a boiler, and the liberation, at once, of a large mass of steam and water, which is practically impossible with the water-tube form, as demonstrated by the early experiments of Jacob Perkins, who frequently raised his steam pressure until rupture occurred, but no ill effects followed.

Dr. R. H Thurston, in writing upon this subject, says: "The author would often use the shell-boiler where commercial reasons would dictate such use, but would never place a shell-boiler under a building in which its explosion would endanger life or much property; the "safety" class of boiler would be the only form to be wisely adopted in such locations. Shell-boilers should, usually, be placed in detached boiler-houses, and so set, as to position, that danger shall be made minimum, *i. e.*, never pointing toward other buildings." Again, "only sectional boilers should be placed under buildings, shell-boilers should have boiler houses constructed for them apart from the large and more important structures to which they are auxiliary, and this precaution is especially advisable for cases as mills, in which many lives may be endangered." Further, "Statistics show that while the so-called 'sectional' boilers are, in some forms, very liable to minor accidents to their numerous details and small ports, and occasionally with serious results, *the violent and destructive explosions which give rise to such terrible loss of life and property, are all due to failure of 'shell-boilers.'*"

For further facts, and "facts out-weigh the profoundest and most ingenious speculation," I would refer Mr. Le Van to the records of the Hartford Steam Boiler Insurance and Inspection Company, a study of which will doubtless convince him that the writer did have the facts before him when writing his "Systematic Boiler Designing," and that it is never wise to base a sweeping statement upon the results obtained from one's own experiments, or upon the "specially good" results of another.

In reply to Mr. M. E. Doolittle's comments in regard to "Equivalent Evaporation" in the April issue, little need be said, as his criticism is like a badly corroded boiler—it won't bear inspection.

If Mr. Doolittle will refer to the first paragraph under "Proportions" of my article on page 154, he will find: "The term horse-power, as here applied, means capacity to evaporate 30 lbs. of water per hour from 100° F., temperature of feed-water, into steam at 70 lbs. gauge-pressure, or 34.5 lbs. per hour from and at 2 120, which is the accepted unit of measure of the capacity of a boiler."

I hardly know how I could have told more clearly what standard I had adopted, and I think that few readers will fail to understand this point. We have reached our destination, so why go further? "The rest of the rule," as given by Mr. Doolittle, is taken, verbatim, from the Babcock & Wilcox catalog, where it is used as an explanation of one of their tables on the properties of saturated steam. Many trade catalogs contain considerable valuable matter, which is true of this one, but they are rarely intended to be used as text books, so I would advise Mr. Doolittle to consult the standard works on steam boiler designing, a little study of which will, I am sure, cause my formulæ to become somewhat less obscure to him. I am very glad, however, that my result, the method of reaching which is fully explained in less than a quarter column, is right, "or nearly so," as calculated by Mr. Doolittle's method, the description of which consumes more than a column.

I have no objections to be likened to an anvil—they are usually pretty substantial things—but having attacked no one, intentionally or otherwise, I fail to comprehend in what way these remarks apply to me, or to my article on "Systematic Boiler Designing;" and why Mr. Doolittle should wish to use my face as an anvil upon which to straighten out his crooked nails, re-fasten his loosened rivets, pound the wrinkles out of his battered opinion, or attempt to deface it with spiteful blows, will, I fear, remain a mystery until we are favored with more blows from "the hammer."

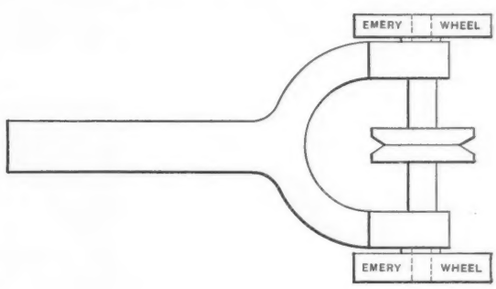
Crooked nails, loosened rivets, and battered opinions, possess little value to anyone, and the quicker they are consigned to the scrap heap, the better it will be for the engineering world in general; and just that much sooner will Mr. Doolittle learn how to deliver a blow that will accomplish some good purpose.

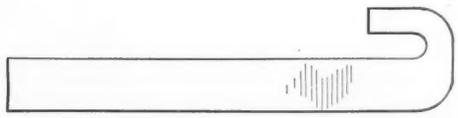
New York, N. Y. H. M. NORRIS.

[We have felt it necessary to omit a portion of this letter as not being pertinent to the case in question. That the bursting of a tube or header is only a safety valve, may be true in a certain sense, but it has been a "danger valve" in more than one instance, and at least two men from one plant that we know of, have been sent to an untimely grave by this form of a "safety valve." Mr. Kent, formerly a Babcock & Wilcox man, remarked at the last meeting of the A. S. M. E., "When you see boilers said to be evaporating over 14 lbs. of water per pound of coal, it is pretty safe to reject the report as unreliable." This makes the reported efficiency of 14.86 pounds of water per pound of coal exceedingly doubtful. As Mr. Le Van was an active participant in the Centennial test, he has probably carefully considered the types of boilers represented at that test. There is a field for both types of boilers and neither can justly claim all the good points with none of the disadvantages.—ED.].

A HANDY GRINDER.

The illustrations show a very handy little grinding attachment for small lathes, and I think only a few words of explanation will be necessary. The frame as shown is made of tool steel and





accurately fitted, so the spindles will run without too much shake. The spindle is made of steel rod, with a brass driving pulley, and small emery or carborundum wheels are cemented on to the shouldered end of spindles; preferably with a different grade of fineness on each end. A number of spindles with different sizes of wheels and grades should be provided. The spindle should be driven from a countershaft back of the lathe, and the pull of the belt will hold wheel to its work, and at the same time allow it to have sufficient play so as not to overdo the grinding. In changing the spindle end for end, or for a different one, it is only necessary to slip the same back from its bearings.

Angelica, N. Y. F. H. JACKSON.

CUP LEATHERS OR HEMP.

It seems to me that the statement made by the writer of "The Evolution of Processes," in the February issue, that the inventor of cup leathers did more harm than good, is a little strong—stronger than the circumstances warranted. I am told by one who was in 'Frisco at the time of the trouble, that the difficulty was more in the manner of applying the cup leathers than from any inherent fault of their own. The pressure was higher than usual at that time, and the form of cup leathers in use by Mr. Dickie was not adapted to this high pressure. They were made in the form of a letter U and let into square cornered recesses, which gave no support to the bend of the leather, and the high pressure simply forced the leather into these square corners and cracked them, so that they would last but a short time, as stated. Had the grooves been round cornered or had a block been arranged to support the bend of the leather, there would probably have been no difficulty.

I am pleased to learn that hemp packing has been used so extensively by Mr. Dickie, in the Union Iron Works, as I like to know that more than one substance can be used for any purpose, but considering the fact that cup leathers are used in a large majority of cases for nearly all hydraulic purposes (in some cases for rams carrying very heavy pressure), it would be a little more becoming if the correspondent in question would use moderation instead of wholesale condemnation of a device which is in general use.

FRANK C. HUDSON.

Tombstone, Ariz.

A KINK FOR THE MOULDERS.

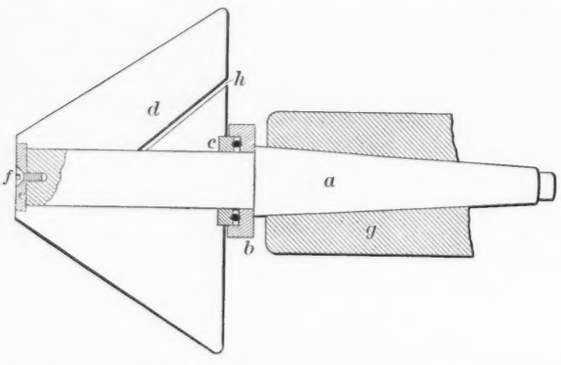
This may not be new to many, but it must be to some as it was to us. We had some peculiar cores to make, and the moulder thought he would have trouble in getting the "vent" off. I suggested using the paraffine tapers that are made for gas lighters. They were tried and with perfect success. They can be bent in any shape and buried in the sand. The process of baking melts the wax and the wick can then be pulled out, having a nice round hole wherever it was placed.

E. S. NEWTON.

BALL BEARING PIPE CENTER.

The accompanying illustration shows a "pipe center," in use at the works of G. M. Davis & Co., Chicago. This will be found to be a device of great value in handling pipes, hollow cylinders and castings, as the conical head will fit a large variety of work, by those who have never employed such an engine lathe fixture; it is also of considerable use in chucking hollow castings.

The special feature embodied is a set of steel balls as shown, which take the thrust and reduce friction to the minimum: *a* is



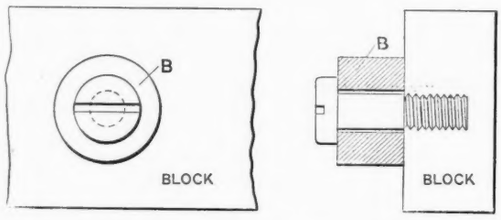
the lathe center shown in place in the tail spindle *g*. *b* is a hardened steel collar mounted on the center *a*, *c* is also a hard steel ring or bushing mounted as shown in the conical head *d*. The rings *b* and *c* are provided with V grooves as shown, in which hard steel balls, such as used in bicycles, are placed. The cone *d* is kept in place by a washer *e* and screw *f*. An oil hole may be located as indicated by *h* to lubricate the surface between the center *a* and cone *d*.

This is a very substantial and easy running fixture, and will be found to be of great value in many kinds of work.

Chicago, Ill. A. BEMENT.

SHOP PROBLEMS.

In answer to "Jigger's" inquiry in your March issue as to the best practice method of drilling the two holes shown in his sketch, so that they will be correctly located, I would suggest drilling and tapping a small hole in each of the given centers, and providing each with a screw and loose bushing, as shown in sketch. By a little rapping one way or the other, these bushings can quickly set in the exact positions required, when the block may be clamped to the face-plate of a lathe and the holes drilled and



reamed to size; the only careful work necessary being the setting of the bushings and afterwards indicating them to run true in the lathe.

H. M. NORRIS.

* * *

BUSINESS.

NO CHARGE IS MADE FOR THE INSERTION OF BONA FIDE ITEMS UNDER THE ABOVE HEAD. FOR FURTHER PARTICULARS, ADDRESS THIS OFFICE.

ANY young firm of fine machine tool builders who are looking for a specialty, would do well to communicate with Wm. Taylor, of England, staying at Westminster Hotel, New York City.

* * *

MANUFACTURERS' NOTES.

THE DAVIS & EGAN MACHINE TOOL CO., have just opened a branch office with the Cleveland Tool & Supply Co., at No. 5 Long street, Cleveland, Ohio., which will be a convenience for customers in that vicinity.

THE FERRACUTE MACHINE COMPANY, of Bridgeton, N. J., make a specialty of sheet metal machinery, and have built up a large trade in this line. They are sending considerable of their machinery abroad, and during the last two years have kept their shops running steadily, with a full force, in making special presses, attachments and dies, mostly for the bicycle and electrical trades. They make a number of presses especially adapted for making bicycle fittings and other parts, and cuts of two of these machines will be found on another page. They have developed the working of sheet metal in bicycle fittings probably farther than any other line of machinery manufacturers, and their experience enables them to produce the shapes in sheet metals which were formerly considered impossible. Crank-hangers, seat-post fittings and other parts of the frames of bicycles can now be made from sheet metal at a small portion of the cost of forgings or steel castings, and they are coming into general use among the largest manufacturers. There are many other articles, such as locks, hardware and electrical goods, which can be made to advantage in presses and dies.

The Ferracute Company issue a handsome catalogue describing 300 kinds of presses, and are always glad to give special estimates on receipt of samples or drawings.

MESSRS. J. C. MCCARTY & CO., No. 97 Chambers street, New York City, have recently been appointed selling agents for the Scranton nail pullers, manufactured by Scranton & Co., New Haven, Conn.

SOME time since an engineer in a large factory called the attenion of a visiting expert electrician to the electricity in a big driving belt, and was quite surprised when the expert informed him that the electricity was caused by the belt slipping. The expert added that it was simply a waste of power and could be prevented by applying Dixon's traction belt dressing, made by the Joseph Dixon Crucible Co., Jersey City, N. J. This dressing was applied and the electricity disappeared at once. Electricity in belts is not only a waste of power, but is also an element of danger by fire.

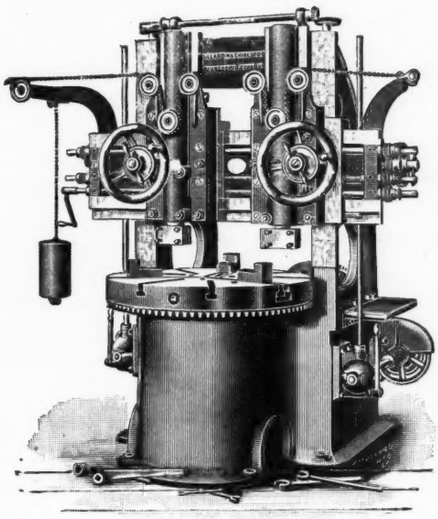
IF keeping everlastingly at it brings success, as we believe it does, the Waterbury Farrel Foundry Co., Waterbury, Conn., ought to prosper. There isn't a month that we are not reminded of their manufactures in an attractive manner, and are usually informed of the machines they have ready for shipment.

MESSRS. DIETZ, SCHUMACHER & BOYE of Cincinnati,O., are about to erect a two story machine tool building, 180x90 feet, and have purchased for that purpose a lot on the corner of Queen City avenue and Buck st. Work will be begun as soon as as possible.

* * *

THE BALL-BEARING CO., Watson St., Boston, Mass. Catalog of ball and roller bearings; 28 pages, 4½ x 7 inches.

This shows various forms of ball and roller bearings, applied to various uses, the truest bearing for drill presses, and seeming to be in wide favor. They shown some very ingenious and substantial devices for various work and say they are prepared to make any form of bearings which are desired.



37-INCH DOUBLE HEAD MILL.

Boring and Turning Mills

Swinging 30 and 42 Inches with Turret Head,

37-51-60 and 62 Inches with Two Heads.

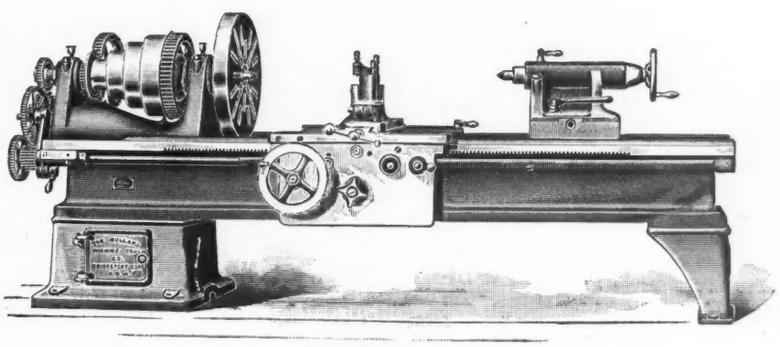
Are self contained, thus making an expensive foundation unnecessary.

Lathes

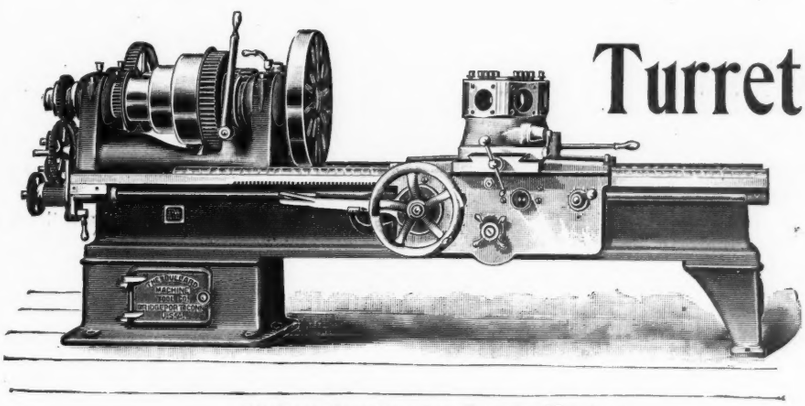
Swinging 14-20-24 26, 32 and 36 Inches.

Extension Lathes,

26-49 and 32-54 Inch Swing.



24-INCH LATHE.



26-INCH COMBINATION TURRET MACHINE.

Turret Machines,

Swinging 20 to 49 Inches, in a variety of forms.

A LARGE STOCK FOR IMMEDIATE SHIPMENT.

The Bullard Machine Tool Co.,

Bridgeport, Conn., U. S. A.

European Agents { Chas. Churchill & Co., Ltd., London, E. C.
Schuchardt & Schütte, Berlin, Vienna, Brussels.

FRESH FROM THE PRESS.

Bicycles and Tricycles. Archibald Sharp, B. Sc. Longmans, Green and Co., London, New York and Bombay. 535 pages; $4.00.

Although this is called an elementary treatise on the design and construction of bicycles and tricycles, to the untutored mind of a meek and lowly editor, it seems quite comprehensive, and we are sure that those who delight in mathematical analysis or graphics, or a mixture of both, will be more than pleased with the author's treatment of even the simplest parts. The various illustrations of machines, which show even more freaks of design than we see to-day, (not excepting the Keating curve) is interesting as showing the general development and should, as the author says, tend to lessen the machines designed without regard to strains or stresses imposed by the work to be done. The book contains much of value, but the mathematics are overdone, according to our way of thinking, and we doubt whether half of the calculations shown ever need be used in practical bicycle building. However, as opinions differ regarding these points, the reader will have to decide for himself.

Easy Lessons in Mechanical Drawing and Machine Design. J. G. A. Meyer. Arnold Publishing House, 16 Thomas street, New York. 1897. Twenty-four parts. 50 cents each.

The first two parts have arrived and show, as might be expected from the author, a very careful and thorough treatment of the subject, which is of almost vital importance to the young mechanic. Mr. Meyer's long practical experience in the drawing room, as a drawing teacher and as associate editor of the *American Machinist*, has fitted him for this work, and judging by the first two numbers, he has the task well in hand. By combining mechanical drawing and machine design in the way in which they occur in practice, the study is made much more interesting than it would otherwise be, and we are confident that anyone who follows Mr. Meyer's careful instruction will derive a great benefit therefrom, more than enough to pay for the books, besides having what promises to be the standard work on drawing for the home student.

The pages have sufficient margin to allow trimming to 9 x 12 inches when bound, and will be an exceptionally fine volume when completed. The illustrations are exact reproductions from Mr. Meyer's drawings, and show what can be done by a thorough draftsman. We heartily recommend this work and shall look forward with pleasure to each number as it appears.

The Practical Management of Engines and Boilers. Wm. Barnet Le Van. Philadelphia Book Co., Philadelphia. Pa $2.00, post paid. 1897.

This is a very convenient size, has round corners, gilt edges and a flexible leather binding, making it particularly handy for the pocket. It includes boiler setting, pumps, injectors, feed water heaters, steam engine economy, condensers indicators, slide valves, safety valves, governors, steam gages, incrustation and corrosion, etc., and is in fact a practical guide for engineers, firemen and steam users generally. The type is easily read, being of good size, and the forty-nine illustrations are clear and effective. The author is an authority on these subjects, and being a thoroughly practical man has the faculty of making things clear to the readers. Readers of this paper will recall Mr. Le Van's writings and will want to add this volume to their library.

* * *

ADVERTISING LITERATURE.

THE STANDARD SIZES FOR CATALOGS ARE 9X12, 6X9 AND 3½X6 INCHES. THE 6X9 IS RECOMMENDED, AS THIS SIZE IS MOST LIKELY TO BE PRESERVED.

SPRINGFIELD MACHINE TOOL CO., Springfield, Ohio. Catalog of machine tools.

This is nicely gotten up with good paper, good cuts and brief descriptions which give the desired information without being tiresome. It illustrates the various sized engine lathes made by this company, from 14 to 24 inch, turret engine lathe, fox lathe, shapers, power presses, straightening press, arbor press and core rod cutter with shears.

THE GARVIN MACHINE CO., New York. Catalog of Machine tools; 160 pages. 4 x 6¼ inches.

In this whole catalog, showing a large line of milling machines, screw machines, gear cutters, special attachments, and the large number of special tools for bicycle work, there is hardly an illustration which is not reproduced in half-tone, showing the rapid increase of this style of engraving. If any one doubts the magnitude of the bicycle business he should study the last portion of this catalog; it is almost a revelation to the average mechanic. The numerous specialties, the special features of the milling machines and other tools of the Garvin make, can best be appreciated by an inspection of this catalog.

WM. JESSOP & SON, Ltd., 91 John St., New York. Catalog of steel; 44 pages, 3⅝ x 5¼ inches.

A handy little book for any user of steel, containing considerable information about working, hardening and tempering. It gives the sizes carried in stock, and several useful weights, etc. Annealed die-blocks in cubes oblong, beveled and round, shapers, are carried in stock or made to order. It will be sent on request.

THE BULLARD MACHINE TOOL CO., Bridgeport, Conn., U. S. A. Catalog of machine tools.

This is a well made little catalog of about 80 pages, which describes the well known Bullard boring and turning mills, lathes and turret machines. There are several half-tone illustrations of their works, which are interesting. It is pleasing to note the substantial design of these and other modern tools in such marked distinction to the very light affairs, about which we were formerly in the habit of boasting.

JAMES L. ROBERTSON & SONS, 204 Fulton street, New York. Catalog of steam specialties.

This is the well known firm of Hine & Robertson under its new name; they need no other introduction. The catalog contains much information about the Robertson-Thompson indicator, Lippincott planimeter, Victor reducing wheel and many other specialties used in and around steam plants. This firm has long been noted for its reasonable priced indicators, which have had a very large sale.

"DOES MODERN COLLEGE EDUCATION EDUCATE, IN THE BROADEST AND MOST LIBERAL SENSE OF THE TERM?" is one of the most important inquiries that could be set on foot. This discussion, which is to be taken part in by President Gilman of the Johns Hopkins, President Dwight of Yale, President Schurman of Cornell, President Morton of the Stevens Institute, Henry Thurston Peck of Columbia, Bishop Potter and others of the most distinguished men of both the United States and Europe, was begun in the April *Cosmopolitan* by a radical inquiry into the educational problem along the lines of Herbert Spencer.

"THEY ALL DO IT," is the title of a little booklet just issued by the Meriden Machine Tool Co., Meriden, Conn., which shows a variety of ways of advertising the same thing. The old-fashioned way, the Wanamaker style, the cigarette way, the street car sign and others, together with a little story of how Mr. Innitt gets all of Mr. Dodbung's business, are all shown. It is certainly worth sending for, whether your case is like Mr. Dodbung's or not.

MR. HERMAN JUSTI, Chief the Bureau of Publicity of the Tennessee Centennial at Nashville, has favored us with a handsome 24 page booklet of the exposition. It is a fine piece of lithograph work, and at a short distance it is hard to distinguish from water colors.

MR. GEO. H. OLNEY, 163 Herkimer street, Brooklyn, N. Y., has issued a new catalog of his model locomotives. These are made from drawings similar to the famous "870" and "999" class of the New York Central R. R. The parts can be bought separately, either finished or in the rough, or the engine can be had complete. There is something fascinating about a locomotive to every apprentice, and we presume many will want to try their hand at making one.

FOR SALE.—Patent No. 577,845, issued March 2, 1897, on new vise, with movable front jaw, stationary back jaw, will hold any shaped object without slipping. An absolute necessity in a machine shop. Terms reasonable or on royalty.
Address, ECKERT BROTHERS, Nyack, N. Y.

LIGHT SHEET METAL STAMPING, and small articles in that line produced at bottom prices. Write for estimate.
FRANK WHEELER & SON, Meriden, Conn.

WANTED.—Salesman to handle a side line of well known tools, on commission. Exclusive territory. Address, "Manufacturer," care MACHINERY, 411-413 Pearl St., New York.

MECHANICAL DRAFTSMAN.—Age, 24; technical education; 5½ years experience in shop and office; desires steady position. Construction of fixtures, special and automatic machines—such as used in manufacturing of sewing machines. Best of references furnished.
Address, "R. P." care MACHINERY, 411-413 Pearl St., N. Y. City.

"HOW TO BUILD A STEAM ENGINE." "BLUE-PRINTS.—The Design and Construction of Modern Steam Engines." Parts 1 to 7 now ready for delivery. Price 30 cents for each part, with working drawings and full description on same. Send 10 cents for sample; stamps taken. Published monthly.
THEO. F. SCHEFFLER, JR., 943 East 21st Street, Erie, Pa.

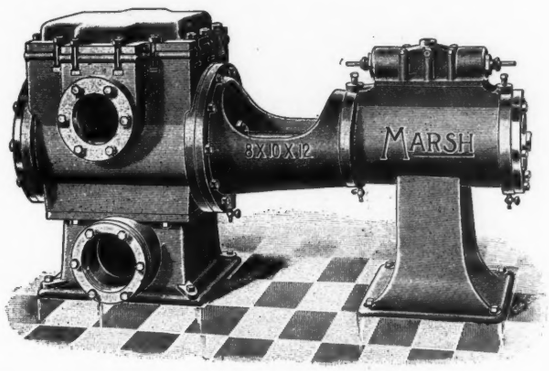
FOR SALE.—A Medium Size Centering Machine, with a complete set of working drawings (single detail per sheet.) A first class design at a very moderate price.
OTTO E. EVANS, York, Neb.

PRACTICAL APPLICATION OF THE INDICATOR, by Lewis M. Ellison, consulting engineer, 317 Roanoke Building, Chicago, is the latest and only work on the subject containing complete directions and illustrations for adjusting engines with the Indicator. *Right to the point.* Price, $2.00.

POINTERS ON PUMPS.—V.

TANK PUMPS.

Until recently it was our intention to confine ourselves entirely to the manufacture of boiler feeding steam pumps—on account of the pre-eminent efficiency of the Marsh pump for that service,—but the great success of this pump as a boiler feeder has encouraged many engineers to predict for it a brilliant future as a general service pump. Believing fully in the merits of the Marsh pump, we have gradually extended our line to meet the constantly increasing demand for low service pumps. We show herewith an illustration of one size, which in a general way fairly represents our present line of tank or low service pumps, which have been extensively introduced and are giving the best of satisfaction to our customers.



These pumps have all the desirable features of the boiler feeders, and are fitted with Tobin bronze rods, phosphor bronze stuffing boxes, valves, etc.—*regularly and without extra cost.* In fact the very best of both material and workmanship are used throughout. Write us for our new catalogue, etc.

THE BATTLE CREEK STEAM PUMP CO., Battle Creek, Mich.—*Adv.*

FOUR TO ONE.

Cleveland, March 18, 1897.

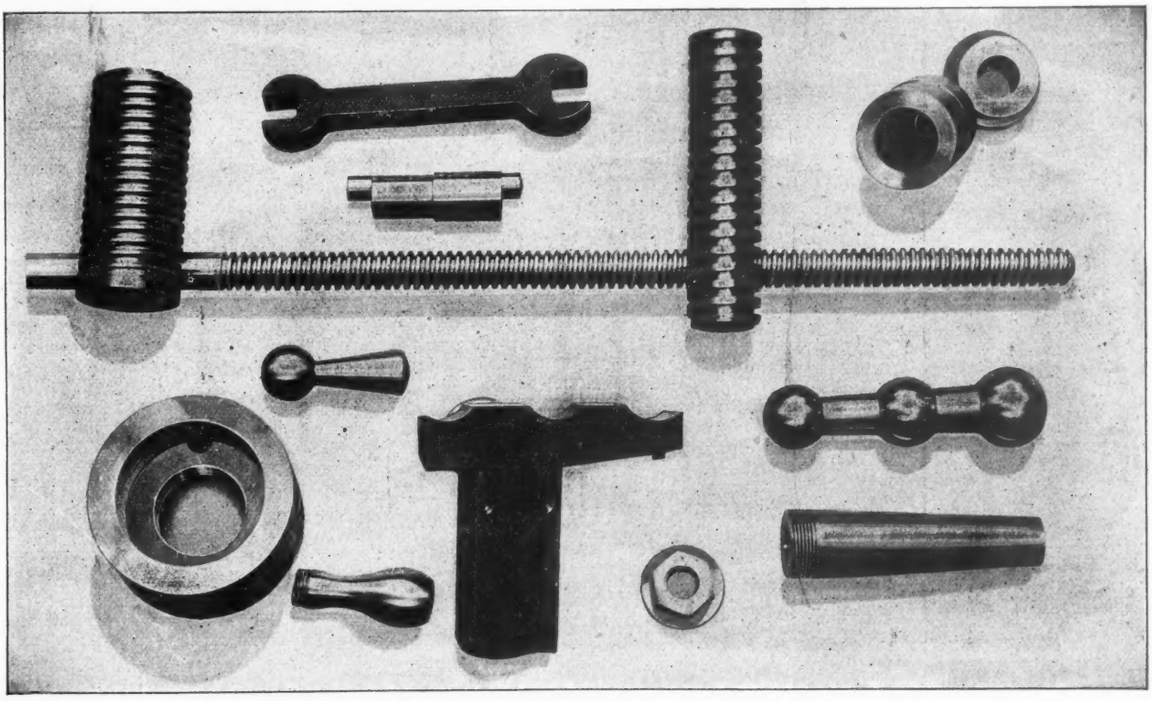
All our advertisements in the various trade journals which we patronize are keyed. Between March 1st, 1895 and March 1st, 1897, we have kept a close record of results, and upon looking it over now, we find that MACHINERY has brought us just about four times the number of inquiries that we have received from any other source.

THE HART MFG. CO.

A New Lathe System—IV.

If you have three or more Lathes turning out similar work under the conditions described below, we can save you from 50 to 80 per cent.

We now ask your attention to the QUALITY and RANGE OF WORK our machines are capable of, showing below some pieces turned on a 2 x 24 Flat Turret Lathe, with the use of a few extras.



The large screw is 1⅞ inches in diameter; the forming tool has a cutting edge of 5¼ inches for shaping the ball handle at its right in the engraving; eccentric jaws for the Automatic Chuck are used on such work as the cam, which appears below the wrench; the wrench may be turned from flat or round stock.

These machines are built for doing Lathe work, particularly that class coming between ¼ and 2 inches in diameter, and less than 24 inches long, in lots of not less than 6 to 10 pieces of a kind. Chucking work up to 14 and sometimes 16 inches is also handled, most rapidly and with greatest accuracy, also work up to 36 inches in length; but the field covered without special appliances is under 2⅛ inches in diameter and less than 24 inches long. The saving on this work varies from 50 to 80 per cent., and will generally average 70 per cent.

Our method of demonstrating the saving makes it possible to know just what the machine will accomplish in each shop, and places no responsibility on the people giving us an opportunity to make the demonstration further than that they agree to accept and pay for the machine as per quotation, if such a saving is proven. Where it is not practicable to visit a plant we can furnish estimates from samples of the work or sketches.

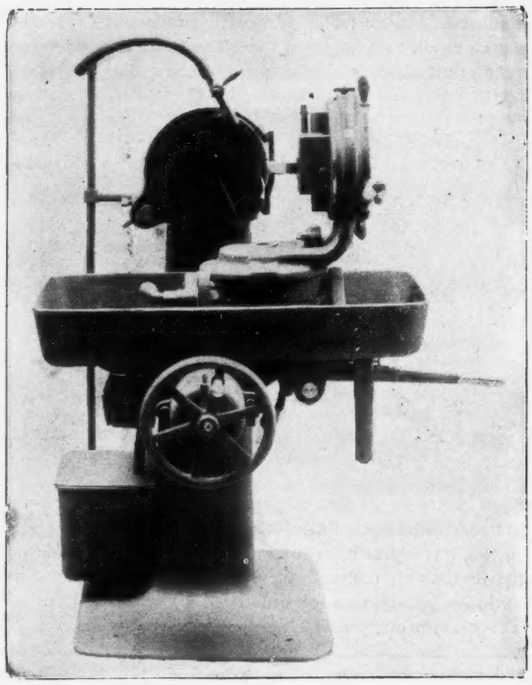
JONES & LAMSON MACHINE CO., SPRINGFIELD, VERMONT, U. S. A.

FOREIGN REPRESENTATIVES—HENRY KELLEY & Co., 26 Pall Mall, Manchester, England.

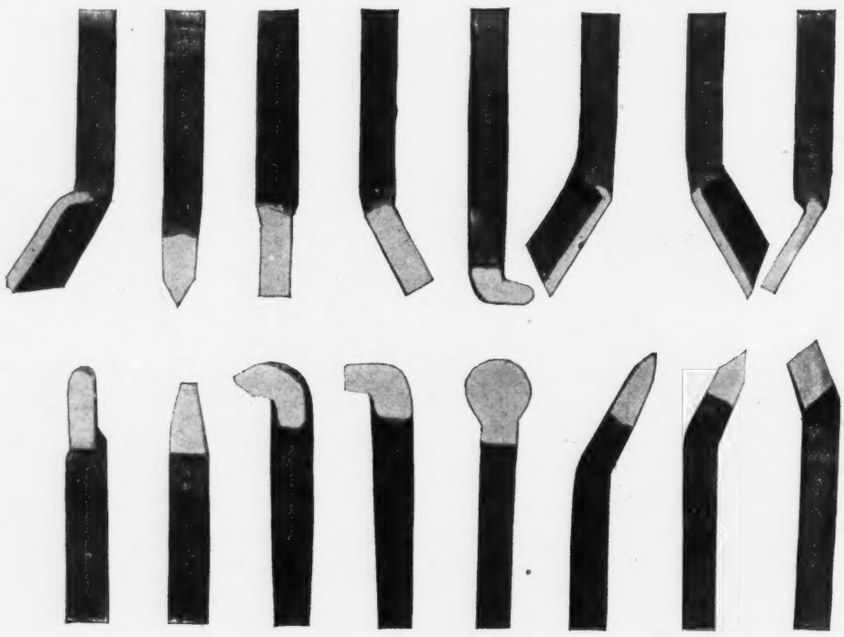
L. KOYEMANN, Charlottenstrasse 112, Dusseldorf, Germany, representative for Germany, Belgium, Holland, Switzerland and Austria-Hungary.

By using a

Gisholt Tool Grinder



you can greatly increase the output of your lathes, planers, shapers, etc. One man can grind sufficient tools to supply about (50) fifty machines. This means that you will get at least **five per cent. more work out of each machine** than you can when skilled mechanics are compelled to use a part of their time grinding their tools. On the "Gisholt" grinder, tools can be ground much faster than by hand, and on the average they will do much more work, as they are given the proper angles of clearance and rake.



The above cuts show a few tools that can be ground on the Gisholt Tool Grinder. Practically all tools in general use can be ground on the machine.

GISHOLT MACHINE CO., Manufacturers of

Turret Lathes and Universal Tool Grinders,

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